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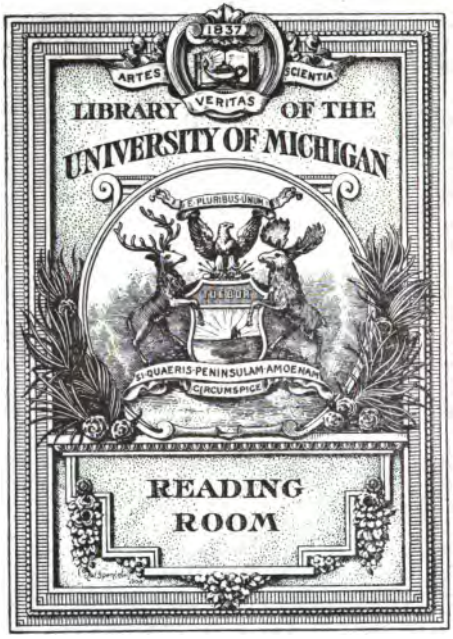
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EDITED BY

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MUNICIPAL ENGINEERING AND SANITATION

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Municipal Engineering and Sanitation

BY

M. N. BAKER, PH.B., C.E.

ASSOCIATE EDITOR OF "ENGINEERING NEWS"

New York

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PREFACE

THIS volume is intended for that large and rapidly growing class of persons who, either as officials or as citizens, are striving to improve municipal conditions. It is designed to be a review of the whole field of municipal engineering and sanitation, rather than an exhaustive study of one or a few branches of the subject. The most vital points, however, under each class of activities and interests have been dwelt upon, the underlying principles stated, and, in many instances, details from actual practice given.

While it is not to be expected that engineers and sanitarians will find in the book much relating to their specialties that is new to them, it is believed that the number and variety of subjects treated, and the comparative newness of some of the topics, will make the book helpful even to professional men.

A few standard treatises have been mentioned in the text or in footnotes. For an exhaustive bibliography, the reader should consult Mr. Robert

109884

C. Brooks's "Bibliography of Municipal Problems and City Conditions" (New York, 1901). This admirable work includes books and periodical literature, both American and European, and is brought down to the end of 1900.

It gives me pleasure to state that in preparing this book I have been greatly aided by my wife, Ella Babbit Baker, who wrote Chapters XIII., XIV., XXI., and XXIX. to XXXII., inclusive, and assisted in revising the whole volume.

M. N. B.

UPPER MONTCLAIR, N.J.
November 7, 1901.

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INTRODUCTION

MUNICIPAL ENGINEERING AND SANITATION

CHAPTER I

The City and its Needs

Great as was the increase in urban population during the nineteenth century, the growth of city needs and of the means of supplying them was even more notable. And yet, as we survey the municipal field, we are forced to admit that most of the achievements of the past have been material and temporary, and only a beginning of what must be done to make our cities truly great. Let us then, before entering upon a detailed consideration of the needs and possibilities of the modern city, take a general view of the subject before us, noting both what has been and what remains to be accomplished.

First of all, we find that while much attention has been given to the numerous ways and means of communication, these channels of intercourse are still largely in the rough. Thus, few of our cities suffer for lack of streets, but the street plans are poorly conceived or mere haphazard growths;

official grades have not been followed, or even established; good pavements are limited in extent or wholly lacking, and such pavements as are put down are not kept clean and in repair. Most cities have as many miles of street railways as are commercially feasible, but both the routes and the connections with other lines are not always adapted to the natural movement of the population; overcrowding is the rule, the safety of passengers and pedestrians is neglected, and it is often a fair question whether carfares should not be lowered. Our telephone service is becoming wonderfully quick and reliable, but on account of the high cost it is available for relatively few. The steam railway terminal facilities in many cities are inconvenient, the stations ugly and unsanitary, and grade crossings with all their delays and dangers are still the rule.

Coming next to municipal supplies, we find that water-works have been introduced in small towns to a wonderful extent, and although quantity as a rule still takes precedence of quality, it is encouraging to note that towns both large and small are now awakening to the value of pure water. The dangers of milk which has been infected, or which is of low nutritive quality, are appreciated in comparatively few communities. As for the public markets so common abroad we have little to show in numbers and even less in appointments. Municipal slaughter houses are rarer still, and perhaps but little needed, under the prevailing American

system of wholesale slaughtering, cold storage, and distribution by a few large companies. We have some very creditable city halls and other public buildings, notably schoolhouses and libraries, but these are in the minority. A few cities have not sufficient accommodation for all the children enrolled, and the sanitary conditions of existing structures are often a menace to health and morals rather than the models which should be found in everything connected with educational systems. It is a common thing for city officials to be scattered about in rented quarters, instead of being conveniently housed in an appropriate hall.

Municipal lighting for streets and houses is far more expensive than it need be, and thus not so well provided as is desirable and would be feasible under improved conditions. Gas light and heat are beyond the means of thousands of people, and electric lights are still more expensive. The use of both gas and electricity for power would increase rapidly with the lowering of rates. Happily, lower prices are coming, both voluntarily and by compulsion.

In the removal and disposal of city wastes we are far behind our attainments in providing municipal supplies. Only a small proportion of the communities which enjoy public water supplies have the benefit of sewerage systems, and most of the latter discharge their sewage into the nearest body of water without regard to consequences. Garbage collection is strangely neglected in the

majority of cities and towns, and its final disposal is one of the greatest blots upon American municipal administration.

As a rule, fire protection of some sort follows or accompanies the introduction of public water supplies. The fire fighters of America are noted for their quickness in getting to fires, the equipment they bring, and the effectiveness with which they use it; still, hundreds of places of fair size are without a paid fire department, many lack proper apparatus, and in many more the water supply is insufficient.

Proper building and plumbing regulations are becoming more common, but there is a great field to be developed before unstable buildings, fire-traps, and bad plumbing disappear. Smoke abatement here and there receives the attention it deserves, but efforts in this direction are likely to be spasmodic and ill-directed. Public hygiene and sanitation are rapidly coming to the front. Among the many needs in this line, none are more pressing than the employment of well-trained, tactful, honest, energetic, and fearless health officials, and a better appreciation by the people at large of what is conducive and what a menace to the public health. Such popular education must begin in the public schools. School children may easily be taught what cleanliness is, the advantages and proper uses of sanitary appliances, and something of the relation between health and disease. This sort of instruction may be raised to higher planes

as the pupils advance. Baths, playgrounds, and gymnasia, both connected with the schools and independent of them, are now recognized factors in municipal work. Colleges and universities, particularly engineering and medical schools, may well have courses in hygiene and public sanitation.

Among so many things designed more especially to maintain and protect property, health, and life and to minister to the comfort and convenience of man, the guardians of the city should not forget the higher life. Sound bodies contribute to sound minds and lofty ideals, and thus good sanitation leads up to an effective demand for municipal art. The desire for the beautiful may be met, in part, by the provision of parks and art galleries, while libraries, lectures, and music may contribute to the same and other noble ends. The beauties of nature should be made as fully available as possible, by means of parks within, and readily accessible nature-reservations without, the city. Pains should be taken to combine the beautiful with the useful in all classes of municipal construction. There should be more coöperation between engineers and both landscape and building architects.

The defects, the needs, and the possibilities of the modern city, so briefly outlined here, and presented in more detail in subsequent pages, are many and various. So numerous and complex are they that, although municipal progress must always depend primarily on good citizenship, it will rest more and more upon a permanent staff of

trained executive officers, supplemented by consulting specialists of wide experience and national reputation. The municipal expert engineer and sanitarian will play an important part in the urban life of the twentieth century.

WAYS AND MEANS OF COMMUNICATION

CHAPTER II

Streets, Pavements, and Sidewalks

The streets of a modern city are far more than mere highways for surface use. Railway cars run above and below as well as on the surface; messages, light, heat, and power are sent through aërial or underground wires; pipes beneath the streets bring us water, gas, and steam; still other conduits remove liquid wastes from our dwellings and surface and subsoil water from our yards and streets. The space between the building lines, especially in the larger cities, bears an important relation to both air and light. And finally, not to make the list too long, well-planned streets afford a most excellent opportunity to relieve the monotony of brick, stone, and asphalt with the ever-changing beauty of trees, shrubs, and flowers.

The rapid growth in numbers and volume of street uses, and the tendency to do away with aërial construction as unsightly and dangerous, combine to increase the demands upon both the surface and underground ways of communication. These multiplying demands make it more and more imperative that street surfaces, and what we may call the underground furniture, be capacious,

durable, readily maintained and repaired, and that there be as little interference as possible between the various functions of streets. Obviously there is a conflict between the surface and subsurface uses of streets unless access may be had to the underground furniture with but little disturbance to the pavement and the earth that supports it. This is possible only where a system of subways is employed. So important is this phase of street construction that its discussion has been reserved for a separate chapter. When subways are not feasible, the disturbance of streets may be lessened by systematically recording the location of all underground conduits. In many cities, not even this is done, and only after repeated experimental diggings can a pipe be located.

To provide ample accommodations for various forms of traffic, streets must be properly located and of suitable width, with easy grades and a surface well adapted for vehicles and pedestrians. Conditions affecting the public health must be given a most prominent place. In built-up areas it is often true that the location, grade, and width of streets cannot be altered except at great expense and inconvenience. The character of the surface is more fully within municipal control.

In laying out new streets the conditions essential to their maximum usefulness may be met with greater ease. Other things being equal, the location is fixed by the fact that a straight line is the shortest distance between two points, but it is

sometimes shorter in distance as well as in time to go around a hill instead of over it. For artistic effect streets may be laid out on curved instead of straight lines; or curves may be used to preserve a bit of natural scenery, like a clump of trees, or to follow the windings of a river or lake, or the graceful contours of a hill.

Grades, or surface slopes, are likely to be extremely obstinate factors in laying out streets. If the natural surface of the ground is flat or very hilly, it must be utilized nearly as it is found, any practicable changes of the natural levels having slight effect, unless the land be so valuable as to warrant large expenditures for grading lots as well as streets. But where the land is neither flat nor on a steep hillside, great relative changes in grade may be made with comparative ease.

From the standpoint of the usefulness of the street itself, and of its relation to health and comfort, the connection between grades and the kind of paving material which may be put upon them is of prime importance. The rougher forms of pavements are necessary for the steeper grades, in order to furnish a foothold for horses, but they are hard to clean, noisy, and uncomfortable for those who ride over them.

Finally, street grades may be made to contribute largely to the æsthetic side of urban life by substituting pleasing slopes for level stretches and, when combined with judicious location, by affording commanding views.

Wide streets and avenues, particularly when bordered with trees, add greatly to the attractiveness of a city. They also contribute to ease of communication. The width necessary for the highest degree of usefulness depends chiefly upon the volume and nature of the traffic to be accommodated. If surface railways must be placed in the streets, the width of the streets should be increased accordingly. Serious drawbacks to very wide streets are the first cost of the necessary land, grading, and pavement, and the subsequent expense of maintenance, including sprinkling and cleaning. A number of cities which have learned by experience that their streets were wider than the traffic demanded have devoted a portion of the width to grass and trees. Either the grass plot between the sidewalk and curb has been enlarged, or a strip of sod has been put down in the centre of the street. Among such cities may be mentioned Omaha, Nebraska; Jamestown, New York; and Columbus, Georgia.

The success of street pavements depends very largely upon the character of their drainage and foundation. If either of these is imperfect, the whole pavement is bound to be unsatisfactory. Proper drainage includes ample provision for the quick removal of both surface and subsoil water. Surface water is a nuisance in itself, and it hastens wear by the formation of ruts and hollows. In addition, it tends to rot asphalt. If water penetrates a pavement, it will make sad havoc by

freezing and heaving, and by causing settlement in spots. Surface drainage is secured by proper grading and by giving the pavement an arched surface. Underdrainage is provided by filling trenches with loose stone, or by laying either agricultural drain tile or sewer pipe, both with open joints. Frequently the soil is so porous as not to require artificial underdrainage.

As a rule, all pavements require a solid artificial foundation. Its first cost is high, but once in place it will outlast many successive layers of the pavement proper. In fact, the asphalt, brick, stone, or wood blocks which are seen in a street are only wearing surfaces, like the plank on a bridge or the carpet on a floor. The more firmly and evenly the wearing surfaces are supported, the longer they will last.

The various classes of paving material commonly employed are sheet asphalt, brick, block asphalt, granite, and other stone blocks of fairly uniform size and shape, wooden blocks, and broken stone compressed by means of rollers. The latter class is called macadam when the stones are of nearly the same size, and telford when a foundation of larger stones is used. Macadam and telford are not always included in the list of paving materials, but in view of their general use and many good qualities they seem to deserve such a place. Streets with a gravelled surface can hardly be called paved, although they may be greatly improved thereby. Both macadamized and gravelled

surfaces are being used more and more extensively on country roads, for which they have the necessary qualifications of low first cost and of serviceability under light traffic. Cobblestone has not been included in the list of paving materials, although the only apology for a pavement possessed by some of the older and less progressive cities. As generally laid, directly on the earth, it soon gets out of surface, and for this and other reasons becomes unendurable, when judged by the modern standards of smoothness, cleanliness, and noiselessness. If placed on a good foundation, cobbles would be more serviceable, but after incurring the expense of constructing a good foundation, few cities would be likely to place cobbles thereon.

Certain closely related characteristics belong to each kind of paving materials and determine its serviceability for a given location. Smooth pavements are also slippery. Their surface is easily cleansed, but, having a corresponding facility for scattering dust, they require frequent sweeping or washing. Hence sheet asphalt is least appropriate for steep hills, and may be very dusty on any grade. Slipperiness lessens through the range of paving materials — wood, brick, and granite blocks — till we come to cobblestone.

Where there are large volumes of heavy traffic, granite blocks of uniform size are unquestionably the most serviceable paving material. They furnish a fairly even surface, and still afford a pretty

sure foothold for horses, if the streets are kept clean. Care must be taken to select granite that does not wear smooth nor chip easily. Other rocks make good pavement, notably the Medina sandstone. Trap or basaltic rocks are also durable, but do not come in such uniform shapes, and therefore make a rougher surface.

Brick is considered by many, particularly in the centres of paving-brick production, to stand at the head of paving materials, although this is by no means universally conceded. For ease of traction brick is surpassed only by sheet asphalt, and it is better able to stand heavy traffic.

The objections to asphalt on account of its slipperiness have already been mentioned. These are particularly troublesome in wet or frosty weather. Unless its component parts are proportioned with the greatest care, asphalt tends to crack in cold weather and to soften and get out of surface in hot weather. Yet asphalt is a favorite, and its use is being rapidly extended. Block asphalt has some of the characteristics of sheet asphalt and of brick. In general usefulness it ranks with the latter.

Wooden pavements in America have been declining in favor for a number of years, and are now little used, even in great lumber centres. They are very popular in some foreign cities, especially the Australian hard woods. It is questionable whether these hard woods have been used long enough in England to determine their

durability. In this country they have been given no trial worthy the name. Much of the disfavor into which wood has fallen in America is due to the improper preparation and laying of the blocks and to the lack of a suitable foundation. Rough and dirty street surfaces have been caused by these defects.

As for macadam, a well-surfaced street of this material is generally found satisfactory for light business or pleasure driving. It offers more resistance to traffic than the regular paving materials, but this matters comparatively little where the traffic is light. For heavy traffic macadam is most unsuitable, both because of its frictional resistance and perishability. The surface layers are cut into and rolled up by the wheels, and the even surface soon gives place to ruts and hollows and alternate dust and mud. Macadam is often at its best on steep grades, because of the superior drainage and light loads at such points. It is about the only improved street surface put down in narrow strips in the centre of the street, with a shoulder of gravel or ordinary dirt between it and the curb line. In smaller towns this strip is often not more than sixteen feet wide, and it is sometimes as narrow as eight or ten feet. Certainly country roads are vastly improved by putting down a central strip of firm, smooth macadam, with a well-compacted shoulder of earth or gravel on each side to enable vehicles to turn out in meeting or passing.

Anything like the universal substitution of motor vehicles for those drawn by horses must be far in the future, but for certain forms of traffic it bids fair to be a feature of the next few decades and a factor that must be considered in providing street pavements. The general use of motor vehicles would simplify street problems by lessening the wear due to horses' hoofs, and diminishing street dust and dirt; but for some years to come the tendency will be for the motor vehicle to increase rather than decrease the expenditures for street improvements, owing to the resistless demand for better streets which is sure to follow its introduction.

The relative healthfulness of different kinds of pavements deserves more attention than it has yet received. One of the chief dangers to health connected with pavements is the dissemination of disease germs. When deposited on pavements, these germs may adhere to the shoes of pedestrians and to the skirts of the large but diminishing number of women who, in defiance of personal and public health, persist in wearing long dresses on the street. Disease germs may also be blown about by winds, finding hosts both out of and in doors. The particular disease most likely to be spread in this way is pulmonary tuberculosis, but diphtheria and possibly other diseases of the throat and lungs may be contracted in the same manner. It is partly on this account that ordinances against spitting in public places are being enacted by leading boards

of health. Diseases of the digestive tract may be caused by the access of their specific germs to the mouths of persons on the street, but infection is more likely to occur from foods or drinks into which germ-laden dust from the street has fallen.

Street dirt itself in the form of dust is harmful to the eyes and respiratory organs. Every housewife knows how penetrating dust is. In every well-regulated city the attempt is made to keep the streets as free from dust and dirt as possible, and by means of sprinkling to keep down such dust as is inevitable. As has been suggested, the smoothest pavements are the easiest to keep clean, but their very smoothness aids the scattering of dust by every wind that blows. The natural dampness of wood blocks tends to prevent the formation and spreading of dust, but fibres broken from the blocks are light enough to be blown about, and are particularly irritating to eyes and nose. One of the gravest sanitary charges against wood pavements has been that through their dampness and dirtiness they become breeding places for disease germs. Such conditions may prolong their life, but it is very doubtful whether any germs harmful to man ever actually multiply on street pavements. Such bacteria, it must be remembered, are parasitic, and man being their natural host, they may live but not flourish elsewhere. Sunlight and desiccation are nature's germicides; hence smooth, dust-forming pavements, like asphalt and the best brick are

agents of bacterial destruction. Dampness of pavements is in itself prejudicial to health, on account of its effect upon the atmosphere and upon the feet of pedestrians.

Two other requirements of pavements, from the standpoint of health, are noiselessness and smoothness. Vehicles make little noise on asphalt or brick, but the horses' hoofs ring out loud and sharp. Sometimes brick emits a rumbling sound, believed to be due to imperfect foundation or to the rising of the pavement in an arched form due to the force of expansion. This rumbling is not considered a necessary accompaniment to brick pavements. Wooden blocks on a good foundation are relatively noiseless, this being one of their best points. Stone block pavements are noisy. Macadam is quiet.

Much that is misleading has been written on the relative cost of different kinds of pavements. Comparisons cannot be made without eliminating certain elements which vary with local conditions; such as the amount of grading necessary, character of foundations, differences in the price of labor, material, and freight. It is obviously unjust to compare the cost of brick on a four-inch foundation of concrete with asphalt on a six-inch foundation, when equally good work demands the deeper foundation in either case, yet such comparisons are often made. Again, that brick can be laid at a lower first cost than granite blocks does not necessarily mean that brick is cheaper, since the smaller

cost of repairs and longer life of the granite may more than offset its higher first cost.[1]

It should be the aim of every street superintendent to maintain the streets under his charge in as nearly perfect condition as possible and at a minimum expense. Wear and tear cannot be prevented, but defective spots, such as hollows, ruts, soft or broken brick, should be remedied as soon as they appear. Thorough drainage of the surface and subsoil must be maintained whatever else happens. When the pavement has become too thin or uneven to meet the requirements of traffic, the wearing surface must be entirely renewed. It is at this juncture that the value of a good foundation becomes apparent, since, if it is lacking, the pavement cannot be restored short of complete renewal. This means an entirely needless expenditure of money and a serious interruption to business.

Street sprinkling and cleaning are essential to the maintenance of pavements. Macadam roads, unless kept well sprinkled, ravel badly, during long dry spells. Accumulations of dust retain moisture and thus aid in hastening the wear of the pavement.

Of great value in determining the most suitable paving material for a given street is the taking of

[1] The merits of various kinds of pavements, including relative first cost, are discussed in Austin T. Byrnes's "A Treatise on Highway Construction," and also in George W. Tillson's "Street Pavements and Paving Materials."

a street census. The object of such a census is to learn the character and amount of traffic and, in some cases, the number of slips and falls of the passing horses. When accompanied by records showing the grades of the street and yearly wear of the pavement, street censuses are of great assistance in judging the relative merits of different paving materials. Few, if any, American cities take street censuses, but the custom is common abroad.

Little space needs to be given to the discussion of sidewalks. Good drainage and foundations are prerequisites to good sidewalks, as they are to good roads, and may be secured in the same way. The traffic over sidewalks being lighter and all considerations of traction being absent, less solid work is necessary. A smooth surface, not readily worn by the thousands of passing feet, nor easily affected by the weather, impervious to water, and so graded that water will not stand on it, nor flow over it in perceptible streams, are the chief requisites for the wearing surface. These qualities may be secured by the use of stone slabs; asphalt, sheet or block; brick, gravel, or cinders. The last two are more suitable for side streets or country roads. In addition there is a large variety of compositions, the availability of which is chiefly governed by local conditions. Gravel and tar mixed in varying proportions and combined with other materials are widely used for sidewalks, but care must be taken to proportion the parts so as to avoid softness in hot weather. Board sidewalks are prefer-

able to dirt, at least in wet weather, but are uneconomical, unless lumber is very cheap and all other materials very dear; they are also liable to give rise to many accidents, through loose boards.

The width of sidewalks should not be less than four feet; on many residence streets in villages and even small cities, the space beyond this width is of far more value if devoted to grass. As the traffic increases, the width naturally needs to be increased, particularly in business districts. The ground immediately around trees should not be covered. Neat curbs add greatly to the appearance of a street. Whatever the material of the curb, it should be set deep, on a firm, well-drained foundation, to preserve the grade and alinement. Bluestone, granite, artificial stone, and concrete, the last named protected by iron or steel built into the exposed corner, all make good curbs. When concrete is used, it may be extended horizontally toward the centre of the street sufficiently to form a gutter.

CHAPTER III

Subways for Pipes and Wires

The multiplicity of underground pipes is one of the chief causes of the rapid deterioration of street surfaces. A fine new pavement is scarcely more than thrown open to traffic when along comes a detachment of men with picks and shovels and digs a trench in it to repair some pipe or make a new water or gas connection. A pavement once torn up in this way can never be made perfect again, and often there is little attempt to replace it in even a tolerably good condition. And yet, year after year, a large proportion of the mileage of our city streets is ruthlessly torn up in just this way.

But this is not all. It is becoming more and more difficult to find a place for new conduits beneath the streets of our largest cities. The bursting of a water pipe may undermine and cause breaks in other pipes. Leaky gas mains often go undiscovered, and sometimes result in explosions which injure not only other underground construction, but may damage buildings and cause loss of life as well.

The pressure upon the space beneath street pavements has been increased by the general demand for the abolition of unsightly and often dangerous overhead electric wires. This has led, in a number of American cities, to the practice of placing telephone, electric light, and other wires in underground ducts or conduits, often called electrical subways. Manholes at frequent intervals give access to the conduits for repairs, or for drawing in additional wires, without tearing up the streets.

While electrical subways, once built, give rise to but little further disturbance of the street surface, they do add materially to the crowding and entanglement of conduits beneath the pavement. The obvious solution of the whole problem is to group both pipes and wires in a single large and readily accessible subterranean gallery or tunnel. This has been done to a limited extent in London, Nottingham, and St. Helens, England, in the great sewers of Paris, and in Milan, Italy. More has been accomplished in Paris and London than elsewhere. Such subways are generally large enough to contain many separate pipes and wires. Access is had through manholes, and ventilation is provided through the latter. All the underground furniture may be inspected and repaired with promptness and ease.

To the saving in street construction and maintenance resulting from the use of subways there must be added a vast lessening of labor for gain-

ing access to pipes as compared with those buried in the old fashion. Another important consideration is the diminished leakage from water and gas mains. Then, too, a longer life for pipes might be expected. In support of some of these points may be quoted the experience of Mr. A. Brown, Borough Engineer of Nottingham, England. Writing, in 1892, of the subway in Victoria Street, on which is located the general post office, he said: —

"... There are, besides the gas and water pipes and connections, no less than six pipes containing telegraph wires in this subway, and not one single stone was disturbed in this carriage way for twenty-five years, and in that period not one single penny was spent on pavement repairs in this street. ... The life of the iron pipes and connections in the subway is practically everlasting, as there is no rust; and the expense of relaying mains, and especially gas services, through this cause, is saved."

Although the first cost of a general subway is large, the many savings effected soon more than make it good. A proper system of rentals from the various users will provide for capital charges and operating expenses. Unfortunately it is just these rentals, combined with a fear that their freedom will be in some way endangered, that give rise to the serious opposition put forth by the corporations that would be compelled to use the subways. This has been the experience with general subways abroad and with electrical subways in this country. While the corporations are generally and rightly credited with shrewdness and far-

sightedness, it is well known that they are very likely to overstep themselves in their efforts to keep clear of municipal control. Most of the American electrical subways have been built by the companies using them, either separately or combined. Provision is commonly made for the inclusion of municipal fire and police alarm wires.

The veritable tangle of underground furniture beneath many city streets, the growing necessity of prompt detection and stoppage of leaks in gas and water mains, and, above all, the expense and nuisance of the damage to street pavements caused by so many and such promiscuous excavations, all seem to point to the day when a rational system of subways will be an accepted part of the public works of every progressive city.

CHAPTER IV

The Elimination of Grade Crossings

The abolition of grade crossings, or the intersection of streets or public highways and steam railways on the same level, will be a feature of municipal progress during the next few years. The advantages of the plan need little or no explanation. In the United States more persons are killed every year while crossing railway tracks in a legitimate manner, on the public streets, than while riding as passengers on railway trains. In comparison with such loss of life, mere questions of inconvenience sink into insignificance. Yet the delays to railway trains through lowering speed at crossings, particularly in towns and cities, involves a great loss of time and money to both railway companies and passengers. Add to this the cost of maintaining hundreds of gatemen, bells, and warning signals, and the legal expenses and damages due to crossing accidents, and the monetary phase of the question assumes great magnitude. Nor must there be forgotten the loss of time on the part of highway passengers, nor the injuries, physical and mental, received by them for which no damages are ever secured or even sought.

In some of the larger cities, notably in New York, Philadelphia, Boston, Buffalo, and Chicago, and throughout the states of Massachusetts and Connecticut, much has already been achieved. The two New England states named and New York state, also, have passed general laws prohibiting new crossings at grade except in special cases, and providing for the gradual abolition of such crossings as already exist. In certain cases the expense of abolishing grade crossings in these three states is borne jointly by the municipality, the state, and the railway corporation. The proportion borne by each depends partly upon which of the three initiates the proceedings, and partly upon the relative dates of the construction of the railway and highway. In any event, the work is in charge of the respective state railway commissions.

Other states have followed the example of those named, or have pursued the same general lines independently, though hesitatingly. In not a few instances the railways have separated crossings on their own motion. Doubtless they would take the first step oftener than they do were it not for the heavy construction expenses, and also the advantage of having a public demand for the change, as such a demand aids them in securing consents from property owners and in settling for land and damages.

In the absence of state control the division of cost is usually a matter of agreement between the municipality and the railway corporation. Natu-

rally, the side which originates and presses the demand for grade crossings is likely to pay the biggest part of the bill. In some instances a vigorous exercise of comprehensive municipal police power has so hampered the railway companies by restrictions upon the operation of trains, that, in order to secure relief, the railways have been willing to bear the major part of the expense of elevating their tracks. An example of this has occurred in Chicago, where a large mileage of tracks has been elevated since 1892, the city merely assuming certain legal expenses.

The proper basis of sharing the expense of eliminating grade crossings admits of much local variation. It should depend on the relative benefits resulting therefrom, but these are always difficult to determine. In some states, where the matter is being pushed as a matter of general public policy, the commonwealth pays twenty-five per cent of the first cost incurred on its initiative, the municipality pays twenty per cent or more, and the railway the balance. Under other conditions, where state control prevails, the cost may be divided equally between the railway and the municipality. Naturally there is more reason for a contribution from the state when the work of elimination extends over its whole area and is forced upon unwilling parties. Another fact that should be considered is that in many sections the construction of existing railways was authorized by the state without as much as saying "by your leave"

to the municipalities. In such cases contribution by the state toward the amelioration of conditions for which it is responsible is eminently proper.

Quite as warm a subject for discussion as division of cost is the question of elevation or depression of tracks. Shall the railway tracks go up and the highway down, or the reverse? Such local conditions as drainage, foundations, and character of abutting or adjacent property should decide the matter. In a flat city, with streets all nearly level, any change of grade, either by depression or elevation of the highway, will be a greater inconvenience to traffic than in a hilly city where all loads must surmount grades. On the other hand, when the railway grade at a certain crossing is already heavy, it may be necessary for the street to bear the bulk of the change of grade regardless of the final distribution of cost, it being a much simpler matter to change the grade of a highway than of a steam railway. Sometimes there will be great advantages to all concerned if the tracks are placed in a tunnel. Street grades need not then be altered, and the subsequent damages to private property will be averted.

CHAPTER V

Urban and Interurban Transportation

In no respect does the typical modern city differ more widely from those of other ages than in the advantages which it offers for the speedy movement of men and goods within and beyond its borders. Besides facilitating business, the street railways of a city and its surrounding territory have a profound effect upon domestic and social life. They differentiate the shop and the office from the home, giving greater freedom for the development of both the business and residence districts. Quick transit leaves but little excuse for overcrowding, and by bringing cheap and healthful land into the market, increases the home-owning possibilities of the community.

The maximum usefulness of a street railway depends much upon its location. Good location involves the most direct routes possible for the bulk of the travel and a minimum number of changes from one car line to another. To these ends, it is often desirable to provide radiating lines of track, with a central loop and a belt line to bind the whole system together. Where the traffic is chiefly from one end of a narrow territory to another, as in

many smaller cities, the radial and belt lines become unnecessary, but even then a central loop may be advantageous. Such loops are designed to bring every car past some central point, so a person who starts from any section of the city may pass nearly all the most important buildings of the business centre without changing cars; or, on reaching the centre, may readily transfer to a car taking him to any other part of the city.

Clean and comfortable waiting rooms should be provided at important transfer or starting points, particularly on loops or at the centre of the radial or hub system.

The ideal street railway track does not yield perceptibly to the weight of cars, which is chiefly a question of foundation, and its rails are as nearly continuous as possible, which is a question of joints. It should break the uniform evenness of the street surface as little as possible, so as to reduce to a minimum the interference of the track with ordinary vehicles. The latter condition depends upon the shape of the rail and upon the nature of the pavement where it abuts against the rail.

A concrete foundation is always preferable to wooden ties for the support of the rails. If the underground trolley or cable or any other conduit between and beneath the tracks is used, then a heavy concrete foundation will probably be required for the whole road-bed.

The top of the rail section should be so shaped as not to catch the wheels of carriages, and at the

same time to give a sure and firm support for the car wheels. The accepted standard is a grooved rail, with easy curves to the groove. This permits the pavement to be laid close to the rail on each side. When the traffic is light, a side-bearing rail may be used, particularly if the gauge is such as to allow wagon wheels to run on the inner depressed portion of the rail.

As to the rail joints, the best results are obtained by seeing that abutting rail ends are at the same level, placed as nearly together as possible, and firmly secured to each other. Electric cast-welded joints, made after the rails are in place, are rapidly extending in use. They give a better bearing surface for the wheels and afford an easier path for the return current on its way back to the power house. On the latter account less power is lost and less damage done through electrolysis.

The fitting together of rails and pavement, so as to detract as little as possible from the continuity of the street surface, is a matter which should receive far more attention than it does. The problem would be simpler were it not for the wear of both car and wagon wheels on the edges of the pavement. Where the conditions are such as to result in much wear of this kind, a tougher material, like granite or special brick, may be used for a few inches each side of the rail, toothed into the main paving material. It is sometimes possible to secure very satisfactory results by bringing the asphalt or brick surface close up to each side of

the rail. There is a strong tendency for street railway companies to use rough, if not otherwise inferior material, whenever the paving each side of the rails falls on them. The reasons for this practice are its greater economy, at least in construction, and the fact that the rougher pavements are less attractive than the smooth ones to other forms of street traffic. It is a familiar sight to see what was once a finely macadamized street nearly or quite ruined by a strip of small, rough stone blocks and a line of railway tracks down the centre, and with the carriage traffic crowded off into the gutters.

In some respects worse, because more dangerous, is the line of trolley poles down the centre of the street, rendering a large portion of the highway practically useless and absolutely dangerous for horses and men. The non-use of this part of the street, except by the street cars, sometimes permits the growth of unsightly weeds and tufts of grass. It may result in the disintegration of the pavement, through lack of the compressive effect of traffic, so essential to the preservation of some paving materials.

A centre line of trolley poles should never be tolerated in an ordinary street. Where allowed, the poles should be surrounded with grass plots, protected by curbstones, or both poles and tracks placed in a parklike strip of grass and trees. This adds to the safety and beauty of the street and lessens the dust. Wherever the trolley poles are

placed, they should not only be of ample proportions for safety, but should have artistic lines, and be painted an unobtrusive color. The heavy feed wires should be placed underground in well-isolated conduits.

That horses and mules are no longer commonly used to haul street cars is certainly a cause for rejoicing. Their abolition has been followed by a gain in speed and in street space, and by a reduction in the clattering of hoofs and in street dirt. But we now have the whir and buzz of the motor, the clanging of the gong, and too often great clouds of dust swept up by each passing car.

Except for special cases cable railways are rapidly disappearing. Neither the electric storage battery, compressed air, nor motors generating their own power on the cars have yet been put on such a practical basis as to compete seriously with the electric trolley. The chief objections to this system are the unsightliness of the poles and wires and the dangers incident to the latter, through contact with other wires, breaks, falls, and electrolysis. All these dangers may be greatly reduced, although not fully eliminated, by using great care in construction and operation. The subject of electrolysis is so important that it has been given a separate chapter.

The frequent recurrence of horrible accidents due to losing control of cars, or to cars jumping the track on curves and grades, suggests the importance of having all cars equipped with quick-

acting and powerful emergency brakes and all dangerous curves, crossings, and bridge approaches provided with signals. The agitation for fenders or guards to prevent foot passengers from being bruised or crushed by trolley and cable cars has been so widespread and insistent that more has been accomplished in this line than in others having to do with the public safety; yet the equipment of many street railways might be improved in this particular.

One of the most fruitful sources of danger to street railway patrons is the crossing of street and steam railway tracks on the same grade. The establishment of such crossings should not be permitted in the future and those already in existence should be eliminated as speedily as possible. Where in use, they should be so arranged that the street car must come to a dead stop and the conductor be required to throw a derailing switch out of service before the car can proceed.

Ample provision should be made for heating, lighting, and ventilating street cars. The running of open and closed cars should be accommodated to the weather as closely as possible. But in all these matters, unless it be lighting, it should be remembered that to suit the whole travelling public is impossible. In cold climates consideration for the comfort of conductors and motormen, particularly the latter, demand the use of vestibules to shield them from cold and wind. A half-frozen motorman may endanger the lives of passengers.

Spitting in street cars, as in all other public places, should be prohibited by city ordinances; and the police and the decent public should insist on obedience to the law. The complete stopping of this foul and dangerous practice would diminish the yearly harvest of consumptives and sufferers from other communicable diseases. Even if this evil were wholly stopped, there would still be need for thoroughly cleansing and disinfecting all the cars, particularly the seats, floors, and holding straps. Cushions for seats, if used at all, should be as nearly dust-proof as possible — a washable woven cane or similar covering is desirable.

The regulation of the speed of street railway cars is a troublesome problem. On the one hand, street-car patrons wish to make all possible speed; on the other, there is great danger to pedestrians when cars run through crowded streets at rates ranging from eight to twenty miles an hour. Both the police and ordinary citizens are slow to lodge complaints for violation of speed ordinances and, without special preparation in advance, it is no easy matter to prove allegations as to excessive speed. Some day, perhaps, all street cars will be provided with automatic speed registers.

Elevated railways are limited to a few of the largest cities. As matters now stand, the only reason for building them is to provide more transit, particularly more rapid transit, than the surface railways will give, and the present tendency is to prefer underground to elevated railways for this

purpose. Many of the points discussed in the preceding pages apply equally to elevated railways. They should be so designed as to give a minimum of interference to street traffic, space, and light, and particular care should be taken to render them as noiseless as possible. The adoption of electric power eliminates the smoke, cinders, ashes, and water droppings which accompany steam locomotives.

The whole elevated structure, and particularly the stations, should be well designed, from the artistic as from the utilitarian side. In many cases elevators may be provided with advantage. The waiting rooms should be equipped with proper water-closet and toilet facilities. The elevated lines, and underground railways, too, should be so located as to relieve the crowded street surfaces and make convenient connections with surface railways, the one merging into the other where feasible, and meeting on the same horizontal plane at as many junction points as possible.

It has been suggested with some frequency and force that the logical plan for owners and lessees of property on elevated railways to adopt would be to have retail stores and offices on the same level and directly connected with the elevated railway platforms. Quite recently Mr. Goodhue, in his book on "Municipal Improvements," developed this idea so far as to outline a scheme for a two-story street, all the street railway traffic to be on the upper level, where no other vehicles, save

those of the fire department, would be allowed, while the foot traffic would go above or below as business or inclination directed. This plan, he thought, would greatly lessen the dangers to pedestrians through the separation of street railway cars from all other traffic, but it would involve artificial light for the lower street and the street floor of the buildings. He proposed to devote the street floors largely to wholesale trade, manufacturing establishments, and the receiving and packing departments generally, bringing the latter up from basements and sub-basements.

It does seem a little strange that large department stores and office buildings, when adjacent to elevated railways, have not more frequently provided entrances on the elevated platform level. It would be interesting to know whether the general failure to do this were due to legal difficulties, conservatism, or actual lack of material advantages to be derived therefrom.

Underground railways have the same general reason for existence as elevated, the provision of increased, and particularly more rapid, transit facilities than can be afforded by the surface lines, and the relief of overcrowded streets. They have the advantage over elevated structures of being more completely out of the way of surface traffic, of not interfering with the light of the lower stories of adjacent buildings, and of giving little or no trouble on account of noise. They lend themselves easily to the crossing of streams by tunnel-

ling beneath their beds, thus raising no question as to interference with navigation.

Since the advent of electricity as a motive force, the ventilation of the tunnels or subways in which underground cars are run is greatly simplified. Lighting both the cars and tunnels and hauling the cars present no problems of importance special to underground railways.

The pioneer subway for street cars in America, barring the short stretch on the upper end of Fourth Avenue in New York City, is that extending beneath and beyond the Boston Common. This was chiefly designed to remove the ordinary surface cars from the very congested, central portion of the city, at the same time making it possible to carry more passengers than before, and at a higher rate of speed. Work is now in progress to extend the Boston subway to East Boston. In a similar manner, the long-delayed rapid transit subway now being constructed in New York may be extended ultimately beyond the East River to Brooklyn. New York's underground railway is primarily for rapid transit, although local service will be provided. The system is extensive, both in length and passenger capacity.

The underground railways of London have met with such success that several additions have been completed recently, and still others are in progress.

The rapid extension of electric railways into the suburbs of large cities, and the building of lines to connect a series of towns many miles apart, is

one of the new features of railway transportation. Interurban street railways are similar to urban, except that the longer runs require cars of greater seating capacity and demand higher rates of speed. The interests of ordinary traffic should be safeguarded by choosing the best location for the track in its relation to the centre of the highway.

It may be desirable to have interurban lines carry express, and even freight, as well as passengers and mail.

In some localities, where the trolleys do not run often and the highways are poor, cycle paths might be maintained between or at one side of the rails, with very little additional expense and with great advantage to wheelmen. Another possible accessory to interurban lines is electric street lighting.

The fact that some street railways serve from two to twenty municipalities is a strong reason for putting them under some other than city or town control, since the individual towns, acting separately, cannot always regulate the railways properly, and authority for joint action is lacking. County control might suffice in some cases, but often several counties are involved, which suggests the necessity for state control. In a number of commonwealths, the State Railway Commissions already have jurisdiction over street railways.

The various public vehicles other than street railways used to carry goods and passengers come under the head of urban and interurban transpor-

tation. A well-conceived system of licensing and general regulation to prevent unfair dealings with the public, together with a strict sanitary supervision of passenger vehicles, is all that is necessary to protect the interests of the public.

With good roads, the use of motor vehicles for light traffic seems likely to increase gradually, perhaps rapidly. While the engineering features involved must be left, for the most part, to their manufacturers and owners, questions of speed, braking and lighting facilities, and alarm bells are proper subjects for municipal control. It may prove desirable to have all horseless vehicles licensed, after municipal inspection and approval.

CHAPTER VI

Bridges, Ferries, and Ice-boats

So far as consistent with local conditions, bridges should afford the same accommodations as do the streets of which they are virtual continuations. For the sake of economy of construction and maintenance, it is common practice to make a bridge narrower than the street at either end. This may retard travel, but it is partially offset by the fact that vehicles on bridges are in constant motion.

The location of bridges, where there is a choice, is a matter for most thorough investigation. A careful study should be made of the character of the soil on which the foundations rest and the nature of the stream, if one must be crossed. The latter consideration includes the permanency or changeability of the channel, fluctuations in the water level, and the amount of ice and driftwood likely to be carried down. If the stream is navigable, another series of problems arises, among which may be mentioned the nature and amount of shipping, and whether a movable span must be provided.

Masonry and steel are now the accepted materials for bridge construction. Masonry forms the

most permanent structure and demands the minimum outlay for maintenance and repairs, but its greater first cost often prevents its use and sometimes makes it quite impracticable. Masonry also lends itself more readily to good artistic results, particularly as it does not present such temptations to ornateness as accompany a readily worked metal like steel. The arched forms given to masonry bridges are naturally simple and graceful. The recent introduction of concrete, with light steel or iron embedded in it for added strength, permits a happy combination of pleasing lines and low cost of construction.

It is unfortunately true that foundations are among the weakest points of ordinary bridge construction. There is also a strong tendency to skimp on the superstructure, especially when it is of metal. The increasing weight of street railway cars is adding an unexpected burden to highway bridges, necessitating a corresponding care in the inspection and strengthening of old bridges and in the design of new ones. The matter has been taken in hand recently by the State Railway Commission of Massachusetts, which has adopted general specifications for bridges crossed by electric street railways.

Bad design and improper construction are sure to be followed by heavy bills for repairs and renewals. Such a common but unfortunate sequence of events is usually due to the failure of municipal bodies to employ competent engineering and legal

advisers to prepare plans and specifications, let contracts, and secure their fulfilment.

Cities frequently put themselves at the mercy of bridge manufacturers and contractors by requesting them to furnish and bid on their own plans and specifications. These bids are then passed upon by a body of laymen, incompetent to decide upon the design and cost of such work. Another and very serious evil likely to be encountered is the pool system, or secret agreement among bridge agents. By this means it is determined in advance who shall make the lowest bid, what the amount shall be, and how the excessive profits which alone make such an arrangement possible shall be divided among the various bidders. This evil has been lessened by the recent consolidation of bridge companies. But this, like the pool system, is aimed against competition. For these and a variety of other reasons, the employment of a competent and reliable engineer is an essential to reasonable cost, good material and workmanship.

In striking contrast with European countries, America has almost wholly overlooked the artistic possibilities of bridge design. In a country where municipal art is so much needed, it is unfortunate that this opportunity to secure results at low cost should be neglected. The only difference in price between a pleasing and ugly structure may be the slight fee of a good architect, for oftentimes the same quality and kind of material may be built into graceful and artistic form with no more ex-

pense than is required to produce the contrary effect.

Where more ambitious attempts are to be made, as in the adornment of a bridge with statues and other sculpture, the problem becomes more difficult, and the artistic outcome more doubtful. There must be coöperation between the architect, the sculptor, and the engineer, and the artistic talent engaged should be of the highest order.

It is not within the province of this book to discuss artistic details, but it seems proper to urge upon both engineers and municipal officials that in designing bridges there should be added to the physical qualities of strength and durability, the artistic ones of dignity and repose. These latter qualities may be secured by so adapting form and material to each other as to give pleasing outlines, supplemented by harmonious details. The old maxim "ornament construction, never construct ornamentation" applies here with full force.

It should be remembered that many bridges are seen from both land and water. To enhance their beauty, portals or gateways may be placed at each end. This practice is quite common in Europe. From the bridge a commanding view of the water may usually be obtained. To aid in the enjoyment of this, convenient points of observation, with or without seats, may be provided at intervals.

The possibility of making bridges serve as memorials of citizens or historic events should not be forgotten. This and other æsthetic features of

bridge design have been ably discussed in Mr. Charles M. Robinson's "Improvement of Towns and Cities."

Toll bridges, once so common, have almost disappeared. Like toll roads, they are a restraint upon the movement of men and goods, and are justifiable only under such unusual conditions as high cost of construction compared with the public resources, or their use by a number of communities which cannot readily coöperate in their construction and maintenance.

The number of serious street-car accidents due to street cars plunging into open drawbridges should awaken the public to the necessity of providing effective guards and signals at all such points. It is a comparatively simple matter to have a strong gate come automatically into position with the opening of the draw, thus insuring a barrier for all vehicles and foot traffic.

Much annoyance may be saved people in the vicinity of bridges by sound-deadening construction. This is particularly true in residence and office sections and in parks. That bridges should be well lighted and have their driveways kept clean are rules that need to be put in practice in most communities. Many a bold robbery or foul deed has been committed on a dark and lonesome bridge.

Where bridges are impracticable, ferries become necessary. Their chief disadvantages are slowness, overcrowding, and bad ventilation. For-

tunately most of these objectionable features may be removed, and all of them may be lessened. The substitution of screw propellers for side-wheels gives greater speed and increased cabin room, and thus better ventilation. Double-deck ferry-boats still further relieve the overcrowding and improve the air in the cabins. One of the chief difficulties with most of the attempts at ventilation is the resulting drafts in cold weather. These might be avoided, or greatly lessened, and at the same time the ventilation put on a much more certain basis, by using exhaust fans to remove the foul air. Many people shun the cabins of ferry-boats as they would a mine known to contain coal damp, preferring the pure air of the decks, even though it be cold, wet, or windy.

Where the ferries are long, and preferably in all cases, water-closets should be provided on the boats. Spitting should be prohibited on boats and in the ferry houses. The seats, floors, and walls should be thoroughly cleansed and disinfected at frequent intervals.

One source of annoying delays to ferry travel might be greatly diminished by always providing some mechanical power to assist heavily loaded teams on and off the boats. Some of the municipal ferries at Boston are equipped with small electric motors for this purpose.

In cold climates ice forms in or drifts into ferry slips, making it difficult to effect landings. To aid this and other classes of water traffic, ice-boats

may be employed to break the ice, or to prevent its formation to any considerable depth. The city of Philadelphia owns such boats. They need to be strongly built and provided with powerful engines. Ordinary tugs are sometimes used in place of specially constructed ice-boats, and do very well where the ice is comparatively thin. Ice-boats are sometimes used to keep open the main channel of a stream.

CHAPTER VII

Docks and Harbor Facilities

Cities on navigable waters have few greater possibilities than those connected with the proper development of their water facilities. But how rarely one finds an American city that has grasped the full significance of this fact. Most of our cities have virtually given their water fronts to private corporations, and only a few of those which have retained this valuable property have developed it along rational modern lines.

Both publicly and privately developed docks in this country lack the permanence of construction which is a notable characteristic of the masonry docks of European ports. The superstructures are usually of a most flimsy and combustible character. The latter deficiency was only too well illustrated by the fire on the privately owned Hoboken piers in 1900.

If municipal ownership of docks is to be practised, many of our cities must regain possession of water fronts with which they long ago parted for a song. The frontage must be developed in accordance with modern ideas and leased at such figures as will cover all the expenses of the under-

taking, on the one hand, and not hamper commerce, on the other. The docks, after being properly built, should be equipped with the best available power and machinery for handling goods, such as hydraulic or electric cranes. Ample approaches to the docks, both by land and by water, must be provided.

In some localities it might be feasible to utilize property now of little value or service. Such a course has been advocated for the Newark meadows. Here slips might be dredged out, docks built, and land close at hand reclaimed and utilized for industrial purposes.

The work required in most cities is far simpler than this, being merely the improvement of water fronts already favorably situated. The great question is, how can these promising water front schemes be financed and still be kept in the control of the city? The answer is, by slowly but constantly carrying out a well-conceived plan, on a firm revenue-producing basis. This presupposes good engineering designs, faithfully and honestly executed, and fairly long term leases of the finished docks, without partiality or favoritism toward any lessee.

Although general harbor facilities are largely matters for state or national action, nevertheless municipalities can do much through painstaking investigations of their needs and possibilities. In some cases they may be warranted in spending money to deepen channels or to build break-

waters. A thing to be much desired is less Congressional log-rolling and more river and harbor work based on well merited claims. In addition, millions of government money might be saved if only it were possible to prosecute the improvements with greater celerity and certainty, instead of doing so much work piecemeal.

The interrelation of water and rail transportation should not be forgotten in the intense and bitter rivalry which often exists between the two. Generally speaking, what helps one helps the other, and there should be every possible facility for the speedy transfer of goods from one system to the other, or for economic storage between transshipments.

While the relations between shipping and railway transit are in mind, attention may be called to the superior advantages for sorting out freight cars and interchanging them between different lines which some harbors afford. What is probably the finest example of this sort in the world may be witnessed in the North and East rivers, at New York, Jersey City, and Hoboken. These waters afford the equivalent of hundreds of acres of switching yards and transfer tracks. Not one person in a thousand who sees the great car transfers on the two rivers dreams that they are serving any other useful purpose than slowly and tediously to convey cars from one terminal to another.

CHAPTER VIII

Telephone, Telegraph, and Messenger Service

Of the various means of intercourse none is more important than the transmission of words, or verbal communication. With the postal service the municipality has nothing to do, with the telegraph service but little; for although the telegraph may be used for intra-municipal communication, its development has been far more a national than local concern, thus giving it certain extra-municipal privileges. The public messenger service, in so far as it uses electric wires for operating its call boxes, is within the scope of municipal control.

The telephone is more truly a matter of municipal concern than any of the other agencies of verbal communication. It involves the use of an extensive network of wires which must be supported on poles or buried in the ground. The use of the streets is required in either case. Since burying any class of wires adds still further to the demands upon the underground street space, great care should be exercised to have the work, whether done by cities or companies, permanent in character, with a minimum of tearing up the streets for

repairs or new connections. The best wire subways are provided with manholes, so new wires may be added without more disturbance to the street than the lifting of manhole covers. The wires need to be buried only a short distance below the surface. Many wires may be put in a single vitrified clay pipe, or other conduit, and a number of conduits may be packed close together in a single trench. The use of wooden conduits, unless the wood is very thoroughly protected from rotting, is objectionable.

For verbal communication within city limits the telephone is of vastly greater importance than either the telegraph or messenger service. In fact, the ordinary business man makes far more use of the telephone than he does of the telegraph for municipal communication. Aside from the greater convenience and despatch of the telephone, the chief reason for its local use in preference to the telegraph is its relative cheapness. If the local telephone rates were still lower, the use of this device might be increased many fold. The relatively small number of telephones, as compared with the number of possible users, is ample evidence of the fact that telephone rates are so high as to place the service beyond the reach of hosts of families and business men of comfortable means.

There is a strong popular belief that telephone rates might be cut in two and still yield handsome returns on the capital invested. Municipal ownership or regulation might result in lower rates.

TELEPHONE SERVICE

Most American municipalities have let the control of telephone rates slip away from them without an effort to prevent it. Municipal ownership of general telephone systems is practically unknown in America. While prevalent in Europe, it is more frequently the state than the city which has assumed such responsibilities. The great obstacle to municipal ownership in America, and to most of the private attempts at competition, is that the greatest usefulness of the instrument demands that every telephone in the city be in possible communication with every other one, and also with as many as possible in other cities. In other words, the telephone business is by nature one of the most complete of monopolies, altogether apart from the patents involved. Hence neither private nor municipal competition can take the place of either absolute ownership or a fair degree of control by the municipality.

Without attempting to go deeply into the question, it appears that a wide extension of the telephone service, including the long-distance business, by means of a general lowering of rates, is not likely to occur in the near future, since the companies do not consider the plan to be favorable to their interests, and there is little promise of effective public or private competition. Municipal control of telephone rates cannot be expected without comprehensive legislation. According to all indications this is not likely to be secured until there is a popular uprising to that end. There is much

to be said, both for and against state and interstate control of the telephone service, or a full scheme of public ownership. The question can be raised here, only to suggest the need of a careful study of the whole telephone problem.

MUNICIPAL SUPPLIES

CHAPTER IX

Water and its Distribution

Public water-works rank next to the highways among municipal undertakings. This is not surprising when we consider the intimate relation between water and life, and that many other services, such as fire protection and sewerage systems, are dependent upon water for their existence. Big and little, there are now about four thousand municipalities in the United States which have public water supplies, and several hundred are added to the list each year.

A public water supply is designed, first, to furnish water for domestic purposes, to which end it must be pure, clear, and palatable. Next in importance come fire protection and other public uses, such as sprinkling streets, flushing sewers, and supplying parks. Then follow the various industrial purposes to which water is put, including the production of steam for manufacturing and heating. Garden and lawn sprinkling must likewise be mentioned.

Certain lines of manufacturing, like the higher grades of paper, require very clear colorless water. All water used to feed boilers should be free from

mineral salts that form incrustations, and also from large quantities of sedimentary matter. For fire protection, almost any water not so dirty as to add materially to the damage inflicted on the goods, may be employed. The character of the water used for street sprinkling and sewer flushing is equally unimportant.

It is the use of water for drinking that makes its quality of vital importance. While less than one per cent of the water of a city is used for culinary or drinking purposes, it is the almost universal practice to have the other ninety-nine per cent equally pure. This is done to obviate the cost and inconvenience of a dual supply, and also to avoid the danger that the poorer supply might be used to satisfy thirst.

The essentials of a potable water supply are freedom from disease germs, turbidity, color, odor, and taste.

The most dangerous impurities in water are those due to sewage pollution. The results of drinking a sewage-polluted water are derangements of the digestive tract, typhoid fever, and cholera. The latter scourge has not appeared in this country for many years past, but not only is typhoid one of the leading causes of death in America, but the greater part of it is conveyed, directly or indirectly, through water. This is due to the fact that the typhoid bacillus flourishes in the intestines of man, from which it is discharged in vast numbers. If thorough disinfection of the discharges of typhoid

fever patients were always practised, much danger would be averted, but there are so many careless and ignorant people in the world that this ideal plan is carried out in only a small percentage of typhoid cases. In addition, a constant menace to health is caused by sufferers in the early stages of the disease, and by persons having mild attacks. We must then maintain a continual warfare to secure water as far above suspicion as possible, and must stand ready to purify water where a satisfactory standard is not otherwise attainable.

It must be understood that clearness, or any other good quality of water susceptible of judgment by the unaided senses, is no guarantee of its freedom from disease germs. Nor is there any practicable means, from the standpoint of the water-works superintendent, of telling whether or not a given sample of water contains specific disease germs. The time may come when the bacteriologist can answer the question just suggested, but at present he does well if he can determine the mere number of bacteria in a sample of water. This may be a surprise to many readers, since it is not uncommon for a third-rate or unscrupulous bacteriologist to say that a sample of water contained no typhoid bacilli, when all he could truthfully say was, he had found none.

The chemist is even more helpless than the bacteriologist in his search for disease germs. All he can do is to ascertain what organic impurities the water contains, and then draw his conclusions

as to their origin. To obtain the best results the chemist and bacteriologist should work together. By combining their findings with a sanitary inspection of the sources of the water supply, a fairly sound conclusion may be drawn as to the safety of any given water. If sewage pollution is known to exist, analyses are quite unnecessary, since it will be obvious that an epidemic of typhoid is liable to break out at any time. The choice will then lie between abandoning the old supply for a new and better one, or attempting to purify it. It rarely happens that the color, taste, or odor of water is in itself harmful, but each renders the water less attractive, while either taste or odor may make it unendurable. In the same way, muddy and roily waters are not necessarily harmful, although very objectionable. Certain waters are so composed that some of their constituents attack lead pipes, unite with the lead, and cause lead poisoning. Others act on the zinc of galvanized iron pipes. Either of these waters must be avoided or a kind of pipes selected which will not be affected by them.

Hardness renders water less suitable for toilet and laundry purposes and increases the consumption of soap. It causes the formation of scales in boilers, with the attendant expense for cleaning, repairing, and renewing the tubes.

No mineral found in water gives more trouble than iron. The difficulty is sometimes experienced with water from driven or artesian wells. Such

waters have generally percolated for long distances through sand. During their journey they lose their free oxygen and take up iron, which combines in various forms according to the composition of the sand. When such iron-bearing waters are again exposed to the air, they eagerly take up a new supply of oxygen, which combines with some of the iron and precipitates it in red or reddish brown particles. As time is taken for this action, and as there is generally but little storage for ground water supplies, the water gets well into the pipe system before the changes mentioned take place. Imagine the horror of the model housewife or laundress on seeing her washing suddenly deluged with water loaded with iron rust. Fortunately this iron can be removed from the water quite readily.

Perhaps more exasperating than iron, though generally spasmodic rather than persistent, are tastes and odors in water. These develop with astonishing rapidity and with little apparent reason. They may disappear as speedily as they come. They are due to the life processes and decay of micro-organisms. Bacteria, it may be said here, are still more minute, and for the ordinary numerical counts are observed in colonies. To guard against the taste and odor producing organisms the most that can be suggested in this place is to do all that is possible to deprive them of food materials, light, and air. To shut off the food supply is no easy task. In some cases it may be done by removing all the vegetation, living or dead, and muck

or mud rich in organic matter, from reservoir sites before they are filled with water. Fortunately the worst of these odor and taste producing organisms will not grow without light, and thus may be banished wherever it is possible to cover the reservoir.

Before the study of bacteria and micro-organisms was taken up attempts were made to judge the character of water by chemical analyses alone. Gradually it has become evident that the organic contents of water are of vastly more importance than their mineral constituents. With the advent of the germ theory of disease, and the acceptance of the principle that water is the chief carrier of typhoid fever germs, it became evident that knowledge relating to the organic contents of water is valuable chiefly as an indication of sewage pollution. Hence the point to be settled in most chemical analyses is the amount of organic matter present and whether it is of animal or vegetable origin.

It is much easier to analyze water than to interpret the results of an analysis. The meaning of a sanitary water analysis, that is one for the determination of the amount and character of organic impurities, depends very largely on the fact that organic matter is unstable, particularly when of animal origin, and that the common salt used in human food, and therefore present in sewage, forms an index to water pollution when compared with that of the normal or unpolluted water of the locality. For the purposes of sanitary water

analyses, nitrogenous organic matter only is considered. This changes rapidly from albuminoid ammonia to free ammonia, then to nitrites, and finally to nitrates, forming at the last stage mineral compounds. If then the organic matter is high, and is accompanied by high chlorine (salt), there is good evidence of sewage pollution. If the organic matter is in the form of albuminoid ammonia, it appears that the pollution is of such recent or near-by origin as not to have given time for much of the organic matter to pass beyond the first stage. If, at the other extreme, the nitrates are high, then probably the pollution was remote in time and distance and has been oxidized by bacterial and other agencies. If many bacteria are found in the water, there is still further evidence of sewage pollution. All these factors, together with such data relating to the amount of pollution as is available, will be of great assistance in passing judgment upon the safety of a given source of supply.

The object of sanitary water analysis, therefore, is not to learn the exact quantities of specific substances contained in water, but to secure data on which conclusions may be based as to the chances of infection if the water is taken into the stomach. Albuminoid ammonia, chlorine, and bacteria many times in excess of the quantity that would condemn a water supply might be taken into the stomach repeatedly without any harm, if not of sewage origin. Most bacteria, like most plant life of higher

orders, are perfectly harmless to man. Every one knows that ten or one hundred or one thousand parts of salt in one hundred thousand parts of water would injure no one, but ten parts of chlorine would condemn a water supply, if the latter was located where the normal or unpolluted water contained only two parts per one hundred thousand, because the additional salt in the water must have dissolved out of sewage!

Two words of caution may be given before leaving the subject of water analysis. The first is that if the analyst is to interpret the results rightly, he should have all possible information as to the environment of the water from which his sample is taken; and the second is that a water analysis without proper means of interpretation is of no more use to a city official than a Chinese almanac to a North American Indian.

These reflections suggest the desirability of a well-equipped chemical laboratory for every city and also for every water-works company. Many things need to be done in a city laboratory besides making water analyses, such as, for example, the testing of milk and other food materials and such municipal supplies as oil and cement.

Before passing from a consideration of quality to the conditions governing the choice of a source of supply, it may be noted that an essential element in a public water supply is sufficient pressure to reach the highest plumbing fixtures and throw streams over the tallest buildings. Pipes of too

small size for the demands made upon them decrease the pressure by increasing the necessary velocity and friction. The subject of pressure is further discussed in the chapter on fire protection.

Of the various sources of supply, springs usually rank first and deep wells next in desirability. Both are generally clear, colorless, and organically pure. The character of the water in shallow wells depends upon its past history and present environment. If it has travelled long distances through the soil without encountering organic impurities, or taking up objectionable mineral salts, or if after possible pollution, it has been filtered and purified in its travels, its quality is probably excellent. But shallow wells located in towns or near barnyards or privy vaults should always be regarded with suspicion. A serious objection to all wells, and also to infiltration galleries, as sources of water supply is their tendency to diminish in yield as the years go by. Additional wells dug in the same drainage area do not necessarily increase the yield, since underground as truly as surface water supplies are limited in capacity by the amount of water falling on specific drainage areas. Failure to recognize this fact has caused water famines and a depletion of municipal or private funds in hundreds of American cities. Geologists should always be consulted in developing water supplies, especially from underground sources, since water and water-bearing strata are within their domain.

Running streams and natural ponds and lakes

are the most frequent and ample sources of supply. Their potability depends upon a variety of factors, including the geological and topographical formation of their drainage areas; whether the latter are cultivated, in forest or in pasture; the extent to which they are populated, and the character of the population and industries; whether the wastes incident to both population and industry reach the streams, lakes, or ponds in small or large amounts, and the volumes of water in question.

The evils of sewage pollution have already been dwelt upon. Obviously, nature has less opportunity to render such wastes harmless when they are discharged directly into streams than when they reach wells or springs after flowing long distances through the soil; but if the volume of water be large in relation to the polluting matter, or if the water flows long distances after receiving the wastes, or if it be stored for many days in reservoirs, with exposure to the light and air and opportunity for sedimentation, the chances for a satisfactory supply from surface sources will be increased proportionately. Storage removes mud, silt, and other suspended matter, through sedimentation. It also reduces bacteria. Some of the bacteria go down to their death with the suspended matter, and some die because of unfavorable environment, including lack of food. Light is inimical to bacterial life, and, given plenty of time, it bleaches water high in color, as many surface waters are. While

bacterial life is reduced by storage, other and higher forms are often encouraged by it, and these forms have their part in purification. Unfortunately storage may foster the organisms producing bad tastes and odors, but this rarely happens, in the case of surface supplies, if the reservoir was properly stripped of vegetation before water was admitted.

The choice between the various sources of water described depends on such a variety of considerations that it must be determined by local conditions in each case. But one thing is certain: Polluted water must be avoided or purified. The latter plan is perfectly feasible, and its adoption at the outset, especially in the case of large and rapidly growing cities, may save a large expenditure of money in what is likely to prove, sooner or later, a fruitless attempt to secure a naturally pure supply.

While a dual supply may be undesirable on account of the cost and the danger that the poorer water may be used for drinking, a supplemental supply of non-potable water for such special purposes as fire protection, sewer flushing, and street washing and sprinkling may be a great saving. The subject of a dual supply is discussed in the chapter on fire protection. Where the available supply of potable water is limited or must be filtered, this plan is specially advantageous.

Having outlined the principles involved in selecting and developing a water supply, there remains for consideration the means employed to bring it to the consumer. The network of pipes

provided for this purpose is known as the distribution system, a term which is made by some to include reservoirs, tanks, and stand-pipes.

Where practicable, water is delivered by gravity, but the height of modern buildings makes necessary a greater elevation of the initial supply than formerly. When pumping is necessary, safety demands that the machinery should be in duplicate. Unless the source of supply is ample for all emergencies, reservoirs must be provided to tide over a temporary deficiency, or to accommodate sudden and unexpected drafts, as in a serious fire. They also equalize the pressure.

Tanks and stand-pipes are also used to equalize pressure and to afford a brief, temporary emergency supply. They are often built where no land of sufficient elevation for a distributing reservoir is available. Both tanks and stand-pipes are cylindrical in shape, and are usually built of steel, with a stone foundation. The difference between them is that a stand-pipe is usually much taller and a tank not as tall as its diameter. Both are sometimes enclosed in masonry, and may with advantage be roofed, to exclude dirt and sunlight, prevent the formation of ice of dangerous thickness, and hinder the growths already mentioned as likely to occur when water is stored in the sunlight. Solid foundations must be provided for all water-works construction. Leaky dams, reservoirs, tanks, or stand-pipes may lead to serious accidents, involving loss of life and property, to say nothing of their not fulfilling

their primary object, the retaining of water. All these qualities may be secured with almost absolute certainty if competent engineers and contractors are employed, and if the completed structures are properly maintained.

The choice of pumping engines plays an important part in the reliability and economy of water-works. The demands upon such machinery are extremely variable. Where fuel is expensive and the water must be lifted to a great elevation, high duty pumps should be used; by which is meant complex machinery that secures the greatest possible efficiency or duty from the fuel, but at the expense of heavy first cost for installation. If the lift is not great and fuel is cheap, low duty pumps may be satisfactory. The tendency is toward higher and higher duties.

Boiler plants are more likely to be of inferior quality than the pumping engines. A high degree of intelligence is needed in both the boiler and engine room, if satisfactory service is to be secured.

The pipes used to distribute water to the consumers must be well proportioned to the consumption of the several districts and streets. The minimum size of street mains, with fire hydrants attached, should be four inches, and even this size is not permissible except for short residence streets. A minimum of six inches is better, and six-inch pipe in place costs only a little more than four-inch. When it is remembered that the relative areas of circles are as the squares of their diameters,

and that friction is lower in large than in small pipes, the advantage of the larger pipe is seen. A six-inch pipe will carry more than double the water which will pass through a four-inch pipe under identical conditions. When small pipes are in use their efficiency may be greatly increased by laying larger mains at right angles to them and making connections wherever the lines intersect. The extremities of the smaller pipes in a system, in fact of pipes both great and small, may be connected with an encircling pipe — a kind of belt line. This, combined with the intersecting mains, will help the circulation of water in the whole distribution system, since a sudden draft at any one point may be aided by the flow of water toward it from many other parts of the system. Dead ends should be avoided, since comparative analyses have shown that the water in dead ends is much poorer in quality than elsewhere in the system.

Cast iron is generally used for distributing water. Wood pipe may be employed to advantage where it can be obtained at a lower price than iron. The small pipes leading from the street mains to the houses, known as service pipes, are generally of wrought iron or lead, the wrought iron being treated to prevent corrosion. Altogether the most common treatment for wrought-iron pipe is galvanizing. A japan coating has recently been tried with promising results. Wrought-iron pipe is also lined with lead and with cement. The latter is an old process, which has been applied

to street mains as well. Most cement-lined street mains have been replaced with other material through various causes of failure, one of the principal ones being carelessness of manufacture. Cement-lined service pipes are not in great favor. Lead-lined pipe promises well, but is open to the same danger of attack from certain kinds of water as is lead pipe. Lead pipe costs more than wrought iron, but it has a far longer life. With some waters wrought-iron pipe becomes partially choked with rust in from six to eight years. This interferes greatly with the water service and results in unsightly scars on fine lawns when renewal becomes necessary.

There are so many good makes of fire hydrants that any competent engineer or water-works superintendent will have no trouble in selecting them. Fire hydrants should be thoroughly inspected at frequent intervals, for it is absolutely essential to the safety of a city that they should always be in working order.[1]

[1] A recent and comprehensive treatise on water-works, with bibliographies appended to the most important chapters, is Turneaure and Russell's "Public Water Supplies" (New York, 1901).

CHAPTER X

Water Purification

The means employed to purify water may be classified as follows: Storage for long periods; sedimentation, which is storage or its partial equivalent for short periods; chemical treatment; filtration; and aëration. The so-called electrical processes are experimental. Sterilization by boiling or by distillation is not applicable on a large scale.

The improvements due to storage have been discussed in a previous chapter. Sedimentation is designed to remove suspended matter from water or to clarify it. It is effected by bringing water to rest in comparatively shallow settling basins, or by passing it through such receptacles slowly but continuously. In either case, gravity carries the suspended matter to the bottom of the reservoir, from which it is removed from time to time. The clarified water is either drawn off at intervals, or passes away continuously in a thin sheet, so as to take the uppermost and clearest portion. The period required for clarification depends upon the specific gravity, fineness, and other qualities of the sediment, and ranges from hours to days.

The process may be hastened by using chemicals, generally known as coagulants. Experience has shown that sulphate of alumina, or alum, is the best coagulant. On being added to the water, hydrate of alumina is formed. This is a flocculent precipitate which entangles and carries down with it the suspended matter, both organic and inorganic, and also bacteria. When a coagulant is used, the water is commonly filtered afterward. It has been employed by itself in the settling basins at Kansas City, Missouri, and on a smaller scale in a few other places. Suspended matter may be removed by filtration, but when present in large quantities this practice clogs the filters so badly that little water can be got through them, and that little only by frequent scraping and washing of the filtering material.

To remove organic matter and bacteria to a sufficient extent to render polluted water safe, filtration is employed. If the organic matter is not accompanied by much suspended mineral matter, such as clay or silt, preliminary sedimentation will be unnecessary, but coagulation may be useful, or, indeed, may be required, if it is desired to filter the water very rapidly.

Where reliance is placed on slow sand filtration, artificial beds of sand, three to five feet deep, are provided, resting on six to twelve inches of gravel. At the bottom of the gravel, pipes with open joints are laid. The water to be filtered passes down through the sand, depositing its im-

purities on the surface of the bed and on each sand grain. It then goes through the gravel and into the collecting pipes. The deposit on the surface of the bed is fine grained and more or less sticky, thus acting as a strainer. Millions of bacteria on and in the bed attack the organic matter in the water and change it to nitrates, gradually exhausting the food supply of the bacteria. By a combination of straining and starvation, nearly all the bacteria are eliminated from the water before it leaves the filter. Of those remaining, it is believed that few are disease-producing. Good filters will remove from 98 to 99.5 per cent of bacteria, but as it is important that the final number be low, it is customary to fix a maximum permissible number for the effluent, rather than a percentage of removal, particularly when the bacterial content is high. The absolute bacterial limit will depend much upon conditions of both time and place, ranging from 100 to 300 or even 500 per cubic centimetre. It is best to rely upon an expert to fix the limit to suit local conditions. Chemically the work of a filter bed may be judged by the degree of oxidation or nitrification which it effects. The limits here depend even more on local conditions than in the case of bacteria.

Where coagulants and a very high rate of filtration are employed, say 100,000,000 to 125,000,000 gallons per acre per day against 2,000,000 to 3,000,000 gallons for slow sand filtration, the process is known as mechanical filtration. Such fil-

ters have areas of a few square feet, rather than goodly fractions of an acre, and are confined in tanks of wood or steel. The coagulant and rapid filtration combine to foul the filtering material very rapidly. Cleansing is effected one or more times a day by reversing the flow of water through the filter, stirring up the filtering material by means of power-driven rakes, or compressed air, and wasting the dirty water. The impurities penetrate deep into the filter, instead of lodging at or near the surface, as in the slow sand filter beds. The latter are cleansed by scraping off the thinnest possible layer, by means of special hoes or shovels, and removing it in wheelbarrows. In the best modern practice the dirty sand is washed in a series of ejectors. The wash water carries the sand into one ejector trough after another until the sand is clean. The fouled water is wasted and the clean water is supplied at each ejector. The filter beds have to be scraped from once every few days to once a month. When the beds get too thin, the washed sand is replaced.

The amount of coagulant used in mechanical filtration ranges from a fraction of a grain upwards. The largest doses are generally required for water heavy in sediment, but great care must be taken to see that the raw water contains enough carbonates to combine with the alum, so that none of the coagulant will pass into the effluent without being decomposed — a wasteful process and one which is considered dangerous to health.

The relative merits of the two classes of filters described have given rise to much heated discussion. Within the last few years, careful and extended experiments, on a scale comparable with actual practice, have been made on the water supplies of Louisville, Pittsburg, Cincinnati, and Washington, and similar ones are now in progress at Philadelphia and New Orleans, to determine just what may be expected from the mechanical and what from the slow sand filtration. At most of these places sedimentation, also, was studied, and at some of them very particular attention was given to both coagulation and sedimentation. The water supplies studied are very high in suspended matter, and most of them are badly polluted with sewage. A water low in suspended matter, but polluted with domestic and manufacturing wastes, together with some vegetable matter, was experimented on at Providence, Rhode Island, before the investigations at the larger cities were started. Mechanical filters were studied more particularly at Providence. At Lawrence, Massachusetts, comparatively clear but highly polluted water from the Merrimac River has been passed through slow sand filters in a series of experiments extending over more than twelve years, and still in progress, under the direction of the Massachusetts State Board of Health. Besides the experimental work named, a few regular filter plants of both types have been carefully studied in this country, and many slow sand filter beds have been under careful observation and operation

for years past in England and Continental Europe. The result of all these studies is a mass of data, from which valuable conclusions have been drawn. The consensus of opinion is that either slow sand or mechanical filtration, aided if need be by sedimentation or coagulation, may be relied upon to effect a sufficiently high degree of purification, and at moderate expense. Like most engineering work, the best system for a given locality will depend upon local conditions. It is generally held that with fairly clear waters, like those of New England, and parts of New York and Pennsylvania, slow sand filtration is best and cheapest, while for water heavily laden with silt mechanical filtration may be preferable. When reliance is placed upon coagulants, it is true that either an overdose or an underdose may be dangerous, and the regulation of the coagulant to the varying rates of filtration and character of the water requires great skill and care. Much ingenuity has been expended in attempts to perfect automatic apparatus for regulating the feed to, draft from, and pressure on filters of each class, and on the whole results are very promising. It is not so easy to suit the coagulant to the character of the water and the rate of filtration, but if proper care is taken it is possible. Some leading authorities recommend slow sand filtration for small works and mechanical filters for large works, because the chances of skilful and careful management are greater with the larger than with the smaller plant, and it is

thought that the slow sand filters may be made more nearly automatic than those of the mechanical type.

An important point in favor of mechanical filters is that they will remove a far greater percentage of color than the slow sand filters. Another advantage is that they require comparatively little ground area and small amounts of sand, which are very important points where land is valuable and sand expensive. Slow sand filtration involves high capital charges, but these may be offset by low operating expenses, as compared with mechanical filters. In cold climates, or wherever filters must be covered, the relatively small area of mechanical filters is decidedly in their favor. Such filters are usually enclosed, whereas slow sand filter beds are so large and so constructed that expensive masonry vaulting is generally required in case they are covered.

The cost of filtration under either method may range from $5 to $10 or $12 per 1,000,000 gallons, depending upon a great variety of local conditions affecting both the cost of construction and operation. But $10 per 1,000,000 gallons adds only one cent to the cost of each 1000 gallons of water supplied, and no ordinary family ought to consume (and waste) more than 250 gallons a day. This would make filtration cost less than a dollar a year extra per family, or less than the average charge for one call from a physician.

Tastes and odors should be prevented by the methods suggested in the preceding chapter rather

than remedied by treating the water after they develop. When this is insufficient, aëration, filtration, or both, may serve the purpose. Aëration is desirable in the case of heavily polluted water which is likely to be low in free oxygen — oxygen being an essential to slow sand filtration.

Iron may be removed oftentimes by aëration and filtration, but when in certain forms, chemical treatment is also required. When water from deep wells is lifted by compressed air or air-lift pumps, no further aëration may be needed.

Few attempts to reduce the hardness of a water supply have been made in this country. In general the aim is to precipitate the salts which cause the hardness, after which sedimentation or filtration, more likely the latter, is used to remove the deposit. A water-softening plant was put in operation at Winnipeg, Manitoba, in 1901, which was probably the first attempt of the kind in connection with municipal water-works in North America. A little later in the year a water-softening plant was installed at Washington, Pennsylvania.[1]

[1] Further and more detailed information on the subject of water purification may be found in Hazen's "The Filtration of Public Water Supplies" (New York, new edition, 1900) and Fuertes' "Water Filtration Works" (New York, 1901). The former contains statistics relating to the nature and extent of filtration works throughout the world, besides brief descriptions of a number of filter plants. Mr. Fuertes' book is somewhat broader in scope than Mr. Hazen's, the latter dealing more particularly with purification by filtration.

CHAPTER XI

Water Consumption and Waste Prevention

Next after quality, the quantity of water to be provided demands consideration. Americans generally reverse the rule and place quantity before quality. It seems strange enough to one who is familiar with the 220 gallons per capita supplied daily in Philadelphia to read of the attempts made to reduce waste in English cities where the total quantity supplied for all purposes is from 50 to 25 gallons and less per capita. It is true that conditions are slightly different here. We have more plumbing fixtures in our houses than is the case abroad. While this would rightfully account for only a small part of the difference in consumption, it goes far toward explaining our greater waste. With a multiplication of bath-tubs, wash-bowls, and water closets the increased use is not so great proportionately as the added volume of waste. What looks like a tiny stream of water, if left running the whole twenty-four hours through, will draw more heavily on the water supply than a dozen bath-tubs, kitchen sinks, or other fixtures, when only legitimately used. The more opportunities there are

for such waste, the greater the total volume that flows to the sewers without benefit to any one.

In some cities it is common practice to leave faucets running all night long to secure a circulation in the pipes and prevent freezing, instead of wrapping or packing the pipes, to render them frost proof. Leaky faucets are often left without such simple repairs as the insertion of a new leather washer to replace a worn one; or the ball float valve in a tank gets out of order and stays so for weeks, and meanwhile a stream of water is running to waste. The argument that water waste serves a useful purpose through flushing the sewers is fallacious. Far more efficient sewer flushing, with less water, may be secured in other ways.

Water waste is wrong for many reasons, but most of all because it is one of the chief causes of the impurity of public water supplies. The enormous quantities wasted render it always difficult and sometimes wholly impracticable to secure a new or improve an old supply. Furthermore, this same wasted water, now in the form of sewage, so increases the volume of the latter as to render its proper disposal far beyond the financial capacity of the city, and thus its own or its neighbor's water supply may suffer. These are not imaginary conditions, as the typhoid fever death rate and a sanitary inspection of the water supply of scores of American cities show.

What, then, is a reasonable quantity for the diverse needs of a municipality? There are a num-

ber of American cities, busy manufacturing towns, too, which consume less than 50 gallons per capita per day, the quantity running from 40 to 25 gallons in a few cases. Such results are obtained by a judicious use of meters. From 50 to 100 gallons per day per capita is a liberal allowance, and within or below these limits nearly, if not all, American cities should aim to place themselves.

If a water supply were the only public need of a municipality, watchfulness against waste would be less necessary. But there are a score of other urgent demands upon every city, many of which must remain unsatisfied for lack of funds which might have been saved by more provident management of the water department. When all these other wants have been met, and pure water supplies secured, the advocates of unrestricted water consumption may press their claims.

Various means are employed for detecting and checking the waste of water. Valves are very useful in discovering leakage, for by shutting off valve after valve, one section of pipe after another may be cut out and the effect on consumption and pressure noted. This work is usually done in the night, and, to be most effective, a meter should be placed on each district. Thus excessive night use or waste may be located within narrow limits. If this is not sufficient, detailed inspection of house connections and plumbing may be carried out until the leaks are found. This suggests the necessity of having all underground work as tight as possible

in order to reduce hidden leaks to a minimum. There are 440 joints to each mile of street mains, besides all the joints at valves, hydrants, and pipe connections. Between the street mains and the house meters, where meters are used, there may be many more joints, depending on the distance involved. Most of the leaks of these many joints never show themselves at the surface, but, like the brook, they go on forever. To attempt to locate and stop them means great damage to street pavements and to lawns, besides interrupting traffic and requiring large aggregate expenditures of money. Therefore every reasonable means should be employed at the outset to make all joints tight.

The final and controlling element in the distribution of water is the meter. Without this device to measure the quantity of water sold, the water purveyor and consumer are in a false relation, either side being liable to do or suffer injustice. The water purveyor must attempt to collect sufficient revenue from the consumers to meet the expense of supplying water, and if the water used and wasted is not measured, the apportionment of quantity and cost is mere guesswork. It must be based on an estimated average supply per family, for instance, and thus the careful consumer helps pay for what his careless neighbor wastes. As has been suggested by Mr. John C. Trautwine, Jr., a former chief of the water bureau at Philadelphia, no one thinks of going to his grocer and asking for a year's

supply of table goods at a lump sum for the whole year, but this is just what is done in the case of water, where meters are not used.

A meter should be as much a part of every house supply system as the pipe from the street main to the house. Then every one pays for what he gets, whether he uses it or wastes it; and then, too, every one becomes a water waste inspector, looking sharply after all leaks on the house side of the meter. In no other way can water waste be kept down, and in no other way can the water supplies of the future be maintained in adequate quantity and purity.

Meters should be owned and repaired by the water department, their first cost being included in the capital account, or cost of construction, and their maintenance being charged to the operating expenses. In this way the friction incident to requiring consumers to buy and repair their meters is avoided and the meters are wholly within the control of the department. By charging the consumer a minimum yearly sum for water, regardless of the actual quantity used, the city or water company is insured a sufficient revenue to pay interest and repairs on the meter and the expense of reading it from time to time. The consumer, on the other hand, will find no advantage in skimping in the use of water, which is one of the chief objections urged against water meters.

Besides house and district meters it is desirable that large meters be used to record the total water

consumption. Where there are a number of different sources of supply, a meter should be used to ascertain just how much water is drawn from each source. Such information is useful in studying the seasonal and yearly needs of the city and the possibilities of each source of supply. The aggregate consumption by house and by district meters, checked against the draft on the several sources of supply, will serve to indicate the leakage in the distribution system, outside the house meters, and will thus form a basis of locating and reducing this serious source of waste.

In conclusion, the author may repeat, in effect, what he has said before, in answer to the claims so commonly and thoughtlessly urged, that water should be as free as air. So it is if one will take a pail and bring it to his home as our forefathers did. But when expensive works are required to develop, purify, and distribute water to every floor of one's home, so that turning a faucet makes available a pint or a hogshead, free water for me means that you must pay for yours and mine too, and that other municipal supplies must suffer in order that I may lavishly waste this one. Eventually my day of reckoning will come, for in no other department of human economy is it more true that wilful waste makes woful want.

CHAPTER XII

Pure Ice

The chief dangers from impure water must also be guarded against in the ice supply; that is, ice should not be cut from sheets of water subject to sewage pollution, nor should artificial ice be made from such water. Freezing does not destroy disease germs, but fortunately the conditions most favorable to the production of natural ice exclude a portion of both bacteria and larger impurities from the ice-bearing water. The process of elimination is due, first, to the fact that ice is always cut from relatively still water, which is favorable to sedimentation; and, second, to the forcing downward of foreign matter in the gradual process of ice formation. But ice taken from shallow bodies of water, which freeze nearly or quite to the bottom, is liable to contain dirt and many bacteria in its lower portion. Ice formed from saturated snow is also subject to contamination. A crystal-clear ice, therefore, has much to commend it besides its attractive appearance; still, the only safe rule is to shun all ice from polluted streams or ponds.

The difficulty of securing pure natural ice, combined with climatic and other local conditions, often leads to the production of artificial ice. In fact, large sections of the United States are wholly de-

pendent on the artificial product. By filtering and distilling the water before subjecting it to the freezing process, almost absolute purity may be insured. While this gives greater latitude for selecting a water supply for artificial than for natural ice, it is nevertheless safer to use pure water for artificial ice. It is interesting to note in passing that the principle which tends to free natural ice of suspended matters in the water from which it forms, concentrates the impurities in the centre of artificial ice, since these cakes freeze from the outside inward.[1]

In the distribution of ice to consumers more care might well be taken to keep it free from dirt. It is not uncommon to see ice dropped from carts on to dirty streets, and left on sidewalks and in doorways. Much of the opportunity for contamination thus afforded might be avoided by the exercise of a little care on the part of the icemen and the consumers. Of course the mere rinsing of the ice will remove all dirt thus lodged upon it.

The ice supply of every community should be under the supervision of the health authorities. Every ice dealer should be required to take out a license and state his source of supply. The municipal authorities can then investigate the source and satisfy themselves of its purity. Such a course, supplemented by chemical and bacterial analyses of samples taken from the ice cart at random, and

[1] See studies by Dr. T. M. Drown, Reports Massachusetts State Board of Health, 1888–89 and 1891–92.

without warning, will go far toward insuring the safety of the ice supply.

Individual consumers may protect themselves almost absolutely by never putting ice in drinking water or in contact with food which is not to be thoroughly cooked before it is eaten. Water may be cooled sufficiently by putting bottles of it on ice or in an ice-chest.

CHAPTER XIII

Sanitary Protection of the Milk Supply

The universal use of milk as a food and a drink, and the ease with which it takes up impurities and so becomes a vehicle for carrying disease, renders its sanitary protection one of the most important functions of the city. While the general public has been aroused to the possible danger of contracting tuberculosis through milk from diseased cattle, it does not understand the far greater danger that milk may also carry the germs of other diseases, or may itself produce digestive disorders or result in malnutrition. When we remember that the death of infants under one year is over twenty per cent of the mortality in many cities, and that a large proportion of these children die from diseases which may have been produced by impure milk, the importance of a rigid inspection of the milk supply becomes apparent. Children, however, are not the only victims of a contaminated milk supply. Typhoid fever epidemics, which so often choose the most robust men for their victims, have been traced repeatedly to polluted milk.

The inspection of the municipal milk supply must begin with the dairy farm. The herd itself must be kept in a vigorous and healthy condition, free from all disease and particularly tuberculosis. To make sure of this, city authorities should see that every herd is under the constant supervision of a reliable veterinarian. The food supply of dairy cattle must also be regulated. Slop foods should be forbidden on account of their fermenting qualities. The stables must be large, light, and dry, and scrupulously clean. Manure should be removed at least twice a day. It is an excellent plan to have separate milking and stabling quarters.

Of the utmost significance is the character of the water supply on the dairy farm. No city water supply needs to be freer from chance of pollution. Many a typhoid fever epidemic has been traced to (1) a typhoid patient on a dairy farm; (2) an old-fashioned privy vault; (3) a shallow dug well near the latter, from which water is drawn to wash the dairy utensils, including the bottles or cans in which the milk is supplied to consumers.

Equally rigid rules should be enforced regarding the employees on a dairy farm. How important this is, one appreciates upon reflecting how close is the contact of the milker with the milk. The hands should be washed before milking, and a special over-all suit provided that is not used in any other farm labor. No person having a com-

municable disease should be allowed in the stables or in or near any place where the milk is handled; nor should any water closet or urinal be in the vicinity. An outbreak of scarlet fever in the city of Buffalo was recently traced to a dairy farm where a convalescent patient, a lad of nineteen, milked the cows while desquamation was still going on. In the spring of 1901 an unusually large number of cases of diphtheria were reported within a few days in Montclair, New Jersey. Investigation showed that they were all on the route of one milk-dealer, and that the throats of two of the milkers in his employ contained the diphtheria bacillus. This milk supply was temporarily shut off and a new crew of milkers secured, whereupon the outbreak subsided.

All dairy utensils should be sterilized after being used, and the milk, with as little rehandling as possible, should be placed in the vessels in which it is to be delivered to the consumer.

The foregoing rules may seem rigid, but nothing short of their complete enforcement should be tolerated. To make sure of this, frequent and unexpected visits by a trained inspector are necessary. No dairy farm or dealer should be allowed to ship milk for public use within the limits of the municipality until he has taken out a license. This should not be granted until it has been ascertained that the dairies from which the dealer gets his milk conform to the rules laid down above.

The author recently visited a model dairy farm

in the suburbs of New York, where not only these regulations are enforced, but additional safeguards are maintained. The milk is carried on an overhead cableway from the milking place to the dairy house. Before it is bottled it is aerated and cooled. The bottles are packed in ice, which they never leave till they reach the door of the consumer. There is a steam plant for sterilizing the bottles. Milk furnished by this dairy has been placed in air-tight bottles and carried across the Atlantic without souring.

As in many other branches of industry, the tendency of scientific practice is discouraging to the small producer and favors the large establishment. The small dairy farmer cannot always afford the appliances and close supervision essential to an ideal milk supply. Probably the very worst and most dangerous milk is that taken from a single cow, kept in crowded quarters, fed partly with kitchen refuse, and cared for incidentally by a person who has numerous other duties to perform. Yet many an intelligent householder secures milk from some neighbor whose one cow is thus cared for, and fancies his milk is safer than that supplied by a large dairy equipped with modern appliances.

Many milk supplies, especially for large cities, are furnished by a dealer who simply buys the milk from the farmers in the vicinity and ships it to town. Milk thus gathered is sometimes cleaned by running it through a separator. Henry Dwight

Chapin published in the *Medical Record* for February 10, 1900, an interesting study of the milk supply of Greater New York. To each of fifty milk dealers of the city a list of questions was sent. Nineteen replies were received, all from large dealers whose combined capital ratings equalled about two-thirds of the capital invested in the business in the city. These dealers all furnished bottled milk guaranteed to contain at least four per cent of fat. Nine of the nineteen stated the tuberculin test had been applied to their herds, while others simply said that their herds were under the oversight of a veterinarian. A few of the dealers own their herds, but the great bulk of the milk is collected by companies who have depots in various dairy districts where the milk is bought from farmers. Three of the companies clean their milk with separators. The layer of foreign matter scraped from the side of the bowl of one of these separators was found by Dr. Chapin to contain hair, pus, blood, mucus, fibrin, great numbers of bacteria, and detritus from vegetable matter, probably from fæces!

The shipping of milk is also a process in need of reform. When sent by rail, refrigerator cars should be used, and the milk cans should not be allowed to stand in the hot sun at railway stations. The date when the milk is shipped should be stamped on each vessel and certified by the station agent. Some similar plan of stamping the date of shipment for milk sent in wagons should also be adopted,

thus protecting the consumer from aged milk. If some regulation as to the age of milk were adopted, as, for instance, that milk could not be delivered later than twenty-eight hours after it leaves the dairy, many good results would follow. Among these would be a great lessening of the temptation to use preservatives. Dairy supply firms openly advertise the sale of preservative preparations. These usually contain borax or formaldehyde. Their use, in very small amounts, may not be dangerous, though it has a tendency to harden the casein clot and so make the milk less digestible. The great harm in their use is that the producer seeks thereby to counteract the effects of uncleanliness, especially the failure to keep clean the receptacles for holding the milk.

The delivery of milk by the local dealer requires as close surveillance as its production and shipment. The sale of milk in corner groceries and similar places should be discouraged, the trade being confined, so far as possible, to regular dealers who will carry the milk in properly constructed wagons and deliver it at the customer's door. The use of milk tickets should not be allowed. They furnish a ready means for the transmission of disease, especially when they are dropped, as is the common practice, into the dish which is to contain the milk. Some boards of health forbid the delivering of milk in anything but glass jars. The advantages of this plan are many, especially where a fresh pasteboard cover is used each time instead

of the old-fashioned metal cover. These jars are easily sterilized. The milk when shipped in them does not have to be touched until the cover is taken off by the consumer, thus saving the dipping from can to pitcher in dusty streets. The bottles being full, the milk is not subjected to the shaking and churning process that it would be in partly empty cans into which the milk-dipper must be repeatedly thrust. Certain abuses in using glass bottles must be guarded against. A fine should be imposed for filling a bottle anywhere except at the dairy. Bottles should not be gathered from a house where there is a contagious disease until the quarantine is lifted, and should then be carried away separately and sterilized before being mixed again with other bottles.

All retail dealers, as well as wholesale producers, —where the two are not identical, —should be licensed. The licensee should be required to furnish, at stated intervals, a list of all the dairies from which he buys milk and also a list of his customers. The latter list is kept private by the health board and is designed for use in searching out epidemics.

Frequent dairy inspections should be made by the health inspector and the results conspicuously posted at the rooms of the health board or elsewhere, for the information of the public. Frequent analyses of milk from various carts should be made at unexpected times, to determine the character of the milk, what percentage of fat it contains, and whether preservatives have been used.

Only by conforming to the system of regulations outlined can a municipality be sure of the purity of its milk supply. Tact and wisdom on the part of the officials will speedily secure the coöperation of the local milk dealers rather than their opposition. Such has been the author's experience as a member of the board of health of Montclair, New Jersey, where a milk code quite as strenuous in almost all particulars as the one here laid down is in successful operation. Some of its strictest and most valuable regulations were made at the suggestion of the milk dealers themselves, between whom and the local board of health there is hearty coöperation.

CHAPTER XIV

Markets and Slaughter-houses

The concentration, in a few immense establishments, of a very large percentage of the business of slaughtering, dressing, packing, and shipping meat has decreased the number of private slaughter-houses in America to a marked degree and has greatly lessened the need for municipal establishments. Branch houses in the most important centres distribute the meat products to local dealers, whose stores need frequent and thorough inspection, to prevent the sale of diseased or decayed meats.

What is needed in most of our cities and towns, in the interests of health and economy, is good municipal markets for the sale of meats, fruits, and vegetables. The concentration of this sort of trading in one or more markets makes efficient inspection much easier. It also lessens rents and other running expenses, and gives customers a wide range of choice with little loss of time or energy. The plan also affords an opening to the small dealer having little capital or credit.

Cleanliness should be the motto of every market. To this end nothing can contribute more than the

prompt disposal of all wastes, and ready means for cleaning floors by washing rather than sweeping. Tile, cement, or artificial stone floors may be employed, so laid as to drain freely, but with every precaution against contaminating the air of the market with the gases of decomposition from the market drains and from the city sewerage system. The prompt removal of meat and vegetable refuse from market stalls is easier than its final disposal. The waste meats and bones are eagerly sought by grease and fertilizer manufacturers. The fats of the meat render it easily burned, where no other means of disposal is available, but if this is attempted on the premises, attention must be given to the design and operation of the furnaces. The vegetable wastes are of comparatively little value. They may be mixed with the kitchen wastes of the city and then be burned, or else treated in reduction plants.

Where municipal slaughter-houses need to be provided it will be helpful to learn what is being done in that line in England and Germany. The latter country has the matter much more fully in hand, partly on account of the large measure of state control exercised over the German cities and partly because of the conservatism of the English government in dealing with any and all classes of vested interests.[1]

[1] The information relating to English and German practice and views has been taken from an able review of "Municipal Authorities and Slaughter-houses," read before the Sanitary Institute, at

In Germany each town council has authority to erect and maintain public slaughter-houses, and to forbid slaughtering elsewhere within a prescribed area. It may enact that fresh meat brought from outside that area for the use of restaurants and hotels shall not be prepared for food until it has been inspected. The importation of prepared meats may be, at the discretion of the town council, entirely prohibited. The council may also order that meat not slaughtered at the public slaughter-houses shall be exposed for sale in a separate place; it may prohibit the sale of meat which has been killed outside the public slaughter-house area and within a prohibited district.

The question of meat inspection is handled with equal thoroughness and efficiency. In Germany it is compulsory that all meat should be inspected and stamped before it is offered for sale. Many stamps are placed on each carcass, and as the stamp is a guarantee of soundness, the purchaser is unwilling to accept unstamped meat and therefore enforces the work of the inspector.

Birmingham, England, in 1898, by Mr. E. Parkes, M.P., Chairman of the Market and Fairs Commission of the Birmingham Corporation. See *Journal Sanitary Institute*, Vol. XX., pp. 23–31 (April, 1889). Since this chapter was completed there has come to hand a translation of an exhaustive German work, written in 1894 and revised in 1898. The title-page of the English edition runs as follows: *Public Abattoirs and Cattle Markets*, from the German of Oscar Schwarz, M.D. Edited by G. T. Harrap and Loudon W. Douglas (London, 1901).

Not only public slaughter-houses but markets for the sale of meat are maintained by the public. In large cities these markets are usually located in the suburbs and in connection with the slaughter-houses. They are accessible by means of steam railway and street car lines. Berlin, with a population of 1,700,000, has erected a system of markets, exclusive of slaughter-houses, at a cost of $3,000,000; the cattle market alone covers four acres. Equally ample provision is made in most other German cities, notably Hanover and Leipsic. The markets usually include market halls for live cattle, sheep, and pigs; slaughter halls for the different animals, including horses; cold storage; bad-meat destructors; ice-making plant; rooms for tripe-dressing; fat and tallow departments; and last but not least, the inspection department.

England is far behind Germany in the regulation of the sale of meat. Inspection has not been made compulsory by parliamentary enactment. In 1898, however, the Royal Commission on Tuberculosis recommended measures almost as thorough. They propose the following regulations: (1) That when a municipality shall erect a public slaughter-house it may forbid the killing of meat elsewhere within the town limits; (2) that all meat brought from outside must be inspected before it is offered for sale; (3) all sound meat shall be stamped by inspectors; (4) the sale of meat from any animal not killed in a duly licensed slaughter-house shall be illegal.

MARKETS AND SLAUGHTER-HOUSES

Birmingham has recently erected a city market upon the most approved scientific principles. It includes most of the appliances of the best German markets, but, unlike most of them, is located in the heart of the city. The building provides a mess room for the slaughtermen, and another for salesmen. There is also a coffee-house on the premises. The cost of the building, including an expensive site, was $600,000.

CHAPTER XV

Municipal Office Buildings

The scattering of municipal departments through a number of private buildings is not in the interest of economy, the best government, nor the highest degree of civic pride and interest. On financial grounds, alone, the various offices should be housed in one central building. The rents to private owners thus saved would more than pay the capital charges on the cost of an honestly built city hall. If any city official doubts this, let him ascertain the sum total of rents paid by his city for hired quarters, and compare this amount, capitalized at the prevailing rate of interest on his city bonds, with the cost of a good city hall. The economy does not stop here. The coöperation between different branches of city government, so essential to the best results, demands frequent and easy communication between the departments, thus insuring a better quality of public service, while lessening its cost. Lack of coöperation is responsible for many municipal shortcomings.

First of all, a municipal building should afford

ample and dignified accommodations for the city council, and for as many of the citizens as wish to listen to its deliberations. Next, provision should be made for the mayor and other administrative officers and departments. And finally there should be committee rooms, and a large meeting hall for what may be termed extra-official municipal work, such as the formulation and full and free public discussion of public policy and improvements. The engineering and health departments require well-equipped chemical and bacteriological laboratories for the analysis and testing of numerous materials of construction and operation, and of air, milk, water, ice, and other foods. Facilities for photographic work must not be forgotten, since the use of the camera is increasing rapidly for making records of different stages of construction, and particularly for the exact conditions surrounding street, bridge, or other accidents for which the city may be held responsible. Capacious fireproof vaults are needed to protect the many valuable maps, plans, and books of record and account pertaining to the various departments. The building itself should, of course, be as thoroughly fireproof and durable as practicable.

City buildings should be all that is best in art, utility, and sanitation, since they stand, or should stand, as models to all citizens, and since the qualities named have a most vital effect upon the municipal officials housed by such structures. Bad ventilation and poor light account for hosts of

municipal errors, and for much general inefficiency on the part of municipal employees.

The elevating effect of noble municipal buildings upon the citizens of a community is an important consideration. Those who have visited cities where fine municipal buildings exist, can scarcely have failed to notice the pride and satisfaction with which they are regarded by the most humble citizens. Any object which arouses such ennobling feelings is an uplifting factor in municipal life.

The architecture of a city hall should correspond in character with the dignity of the building, and the relation which it should sustain to the life of the community. Assuming good architectural design, three other conditions essential to the realization of a high ideal may be mentioned: The location of the building, its interior decoration, and the adornment of the surrounding grounds. Certainly the building in which centres the civic life of a community should occupy no mean site. Its location should be as commanding as is consistent with utility. Where feasible the building should be placed in ample grounds. The interior walls may well be adorned with paintings designed to stimulate love of the city and devotion to its highest ideals. The entrance hallway, at least, may afford a place for the work of the sculptor, and, in some instances, the windows may be of stained glass. The grounds about the building may be shaded with trees and decorated with shrubs and flowers. If a fountain can be included, it may be made to add to the

beauty and attractiveness of the whole. A building so nobly planned, so finely decorated, placed amid such surroundings, and visible from all directions, would be a source of inspiration and pride to every citizen.

CHAPTER XVI

Light, Heat, and Power

In municipal economics as well as in physics there is an intimate relation between light, heat, and power. Both gas and electricity are distributed to the public for all three purposes, although gas heating is far in advance of electric heating. Steam heating from central stations is increasing rapidly of late, having received a fresh impulse with the utilization for that purpose of the exhaust steam from electric light and power plants. The steam turbine, recently being developed with vigor, may also increase the demand for steam for power purposes, while gas engines and electric motors, small and great, are coming into common use in shops, factories, and homes. Another means of supplying and utilizing power in connection with municipal works is the water motor, driven by water from the mains of the water-works system. Such a use of water for power is not very extensive, except for running elevators, small printing presses, blowing church organs, and the like. In England there are some notable central installations of hydraulic power, where water under very

heavy pressure is used on docks and similar places to lift freight.

The readiness with which the potential energy of both gas and electricity may be transformed into light, heat, or power, and the great demand for these forms of energy, give them a high rank among municipal supplies. It should be remembered, however, that artificial gas depends wholly, and electricity very largely, upon the consumption of coal or some other fuel for its production.

Compressed air for power is often distributed from central stations, but rarely as a public enterprise. Gasoline and oil are very commonly used, particularly the latter, for both light and heat, and gasoline engines furnish a large aggregate of power. Except for street lighting the use of gasoline and oil is generally of a private rather than a public nature.

Acetylene gas has been laying claim to recognition as a valuable lighting agent, but thus far its use for municipal lighting is confined to a few small plants. Where cheap water power is available, the calcium carbide from which acetylene is generated by the mere addition of water may be obtained at a very reasonable figure. Thus far acetylene has been received with great conservatism in insurance circles, on account of its explosive character. For the present, it demands but little consideration from municipal authorities, except from the standpoint of protection of life and property. Oil, gasoline, and naphtha, for street

lighting, may also be dismissed as forms of lighting easily controlled and not used publicly where gas and electricity are readily available. They serve a very useful purpose, oftentimes, in preventing excessive charges for more desirable lighting methods.

Since the most of the consumption of gas for lighting is concentrated in a few evening hours, it is cheaper to provide storage tanks or gas holders than to install and operate a generating plant sufficiently capacious to meet the maximum demand. The chief interest which the general public has in these gas holders is that they shall not leak so as to contaminate the air and that there shall be no danger of their failure.

The cost of gas is generally divided into two parts: Cost in the holder and cost of distribution. Through labor-saving devices for handling coal and ashes at the gas-works, and through improved generating plants, the gross cost of making gas has been greatly reduced in late years, while the net cost of gas in the holder has been still further cut down by the recovery and sale of by-products.

Had the cost of distributing gas been reduced to any such extent as has the cost of producing and storing it, the people would be clamoring for fifty-cent gas instead of dollar gas, and with good chance of securing the lower rate. It is true that gas mains in place cost less now than formerly, but not enough less to warrant marked reductions in price; nor have leakage and other unaccounted-

for gas, and general operating expenses, been materially lowered.

The one item of leakage and gas not accounted for ranges all the way from five to thirty per cent of the total production. The lower figure prevails in the best systems and the higher figure where mains are poorly jointed at the start and have deteriorated with age, rust, and breaks in the pipe due to settlement, electrolysis, and other causes. Some of the unaccounted-for gas is due to slow meters and some to contractions in volume between the station meter and the house meters, caused by decreasing temperature. But after making due allowances for these factors, gas leakage in hundreds of distribution systems is enormous. If the leakage were cut down to a reasonable figure, large reductions might be made in the selling price of gas. In addition, damages from gas explosions, and from the pollution of soil and air, would be materially diminished. The reduction in gas leakage depends chiefly on better material and workmanship.

It is generally conceded, at least in America, that cast iron is the best material for gas mains, and wrought iron for service pipes. Whichever is used, the pipe must be thoroughly treated to prevent corrosion, the utmost pains must be taken to secure gas-tight joints, and no reasonable precaution against settlement of the pipe should be omitted. If, in addition to these safeguards, gas mains were made readily accessible for inspection and repair,

as suggested for all underground furniture in the chapter on "Subways for Pipes and Wires," leakage from the mains might be kept under almost absolute control. There would still be the service pipes, or house connections. The ideal subway system would include branches for all classes of service pipes and wires; but in lieu of that, effort may be concentrated on making tight joints in the service pipes.

A factor in the future distribution of gas, which may effect great economies in the cost of construction and in saving leaks, is the use of smaller gas mains, with higher pressures to make up the consequent loss in capacity. With smaller mains, much more pains might be taken with joints than at present, and that without any increase in cost. The space thus gained would be of immense advantage in many cities. The pressure under which artificial gas is ordinarily distributed is less than one pound per square inch, while public water supplies are piped through the streets at pressures often exceeding one hundred pounds. Gas under pressure is supplied to railway trains for lighting, and natural gas has been distributed under pressure for many years. Early in 1899, Mr. F. H. Shelton, of Philadelphia, read a paper before the Western Gas Association, advocating the plan outlined above, and citing a few special cases where relatively high pressures had been applied to mains carrying artificial gas in order to increase their carrying capacity. A year or so later Mr. Shelton presented

another paper before the association, in which he described how he had put his theories into practice in several towns.

One marvellous improvement in the distribution, or more properly in the consumption, of gas for light must be noted. It is the Welsbach and other incandescent burners, by means of which more and better light per outlet is secured, and that with a decrease in the gas consumption. This is achieved by the utilization of the heat in the gas, on which account gas with a high calorific power, rather than high candle power, becomes a desideratum. These burners, or mantles, are used for lighting both streets and buildings, and have been of immense advantage to gas men in their rivalry with electric lighting plants. So great has been the effect of the new mantles that some gas managers who had installed electric lighting plants to retain their control of the city lighting have regretted the action as unnecessary.

Gas is almost universally sold by meter measure, except for street lighting, most of the contracts for which are based on a certain number of hours' service through burners of fixed rate and capacity and with gas of a stipulated candle power. Latterly prepayment meters have been introduced extensively in England, and to some extent in America, on the nickel-in-the-slot principle. These meters insure advance payment for gas, and are said to attract much trade which would never be secured otherwise.

Altogether too little attention is paid to gas pressure, particularly in small cities. The pressure of gas, unlike that of water, rises with the increase in elevation of the mains. Consequently, unless the distribution system is well laid out, or pressure regulators installed, the pressure will be low on the lower levels and too high on the hills. Where gas passes through the burners at excessive pressures the combustion is imperfect, and consequently the consumption is unduly increased and the air fouled more than ordinarily — which is altogether too much at best. Fortunately, pressure regulators, either for mains or services, can be secured and installed at low cost. When gas is distributed under the unusually high pressures discussed above, pressure reducers and regulators are essential.

Besides stipulations as to the pressure under which gas shall be distributed to consumers, contracts should state the minimum candle power and heat units (the latter when gas is to be used for cooking, heating, or for incandescent burners) and set a limit for impurities. All these qualities, unless it be impurities, will depend largely upon the kind of gas made and the uses to which it is put. The average candle power for gas in the state of Massachusetts, not including oil gas, from 1895 to 1899, inclusive, ranged from 19 in 1896 to 20.17 in 1898, there being an average of 67 companies and 615 inspections per year. The Massachusetts regulations as to impurities provide that when the gas of any company is found to give less than 16

standard English candles, or to contain more than 20 grains of sulphur or 10 grains of ammonia per 100 cubic feet, or any sulphuretted hydrogen, a fine of $100 shall be paid by such company to the city or town which it supplies. The quality of the gas, as indicated by the impurities named, and the leakage of house piping and fixtures, are two very important sanitary matters that should be under strict municipal control.

The generation of electricity for lighting purposes may be from coal or other fuel or from water power. The relative advantages of the two sources of energy will of course depend on local conditions. In most cases water power is quite out of the question, but the possibilities of long-distance transmission of electric currents is rapidly extending the use of water power for the production of electricity.

The possible utilization of garbage and other city refuse as fuel for developing electric light and power has attracted some attention in this country and much more in England. All that can be said for the plan abroad is that it appears to be a means for recovering a part of the cost of garbage disposal. At home scarcely an attempt of the sort has been made as yet, and the promise for the future is not great. This is due to the small fuel value of American as compared with English refuse, a point that is discussed in that section of this book devoted to the disposal of wastes.

Economies in the generation of electricity are now progressing rapidly along the line of concen-

trating and combining electric light and power stations, thus enabling the use of the most economical equipment, and permitting great savings in operation through the use of coal-handling and other labor-saving machinery. In addition to the benefits just cited, combined lighting and power stations tend toward a much more uniform hourly load (amount of current demanded) than where the two classes of works are separate. Thus, broadly speaking, the bulk of electric lighting is done at night; while the street car traffic is heaviest, the year round, during hours when daylight prevails. During short winter days heavy hours of street railway traffic and of lighting overlap. By using storage batteries the generating machinery for both classes of service may be run during hours of light load, and the batteries may be drawn upon during the heavy hours. The object of the attempts described is to lessen the amount of machinery that must stand idle during a part of each day and thus the capital charges on the plant. Of course the same general end will be effected if contracts can be secured for supplying current to motors used to do work in shops and factories, which are running, for the most part, during hours of light load.

The point has already been emphasized under "Subways," and again in the chapter devoted to street railways, that electric wires should be placed beneath the ground. Electrical subways have been put down for this purpose in many large cities, and the work will be pushed with increasing vigor as

its benefits become more apparent. In the electrical subways access is had to the wires at intervals through manholes.

The relative merits of arc and incandescent street lamps need less consideration than a few years ago, since there is now a tendency to make the first less and the second more powerful. The enclosed arc lamp is also a great gain for arc lighting.

All the wiring system, both street and house, requires care in insulation, to guard against loss of life and property. Frequent inspections are essential to safety.

The sale of electric current by measurement is far less common than the sale of gas, but the practice should be encouraged, in fairness to buyer and seller.

The older street lighting contracts generally called for lamps of two thousand or twelve hundred candle power. Experience has shown that it is better to base the service on a specified amount of electrical energy. It is far simpler to test the volume and pressure of the electric current than its candle power.

When it is desired to ascertain the candle power of either gas or electric lights, resort may be had to photometric tests; that is, comparisons of the lamps in question and standard candles. Such tests are beset with difficulties and are not applicable to street lights in service. The candle power of gas depends upon its composition, while a given amount of electric current does not vary in candle power, provided the pressure is uniform. The actual light

given depends, in each case, upon the quality of the lamps and burners. For these reasons, candle-power tests of gas at frequent intervals are desirable, but to be of value they must be made by a trained observer, with well-designed apparatus. When the prime use of gas is for heating, and when incandescent gas mantles predominate, the gas should be tested for its heating power.

Theoretically, great economies would result from central heating stations. Certainly, there would be a great gain in comfort and health, could the domestic heating apparatus, with all the dust and dirt which accompany it, be banished from our homes. There are, however, a number of obstacles to overcome in establishing such a system.

It is a well-known fact that only a small percentage of the heat value of the coal or other fuel burned in a kitchen range or house furnace is utilized. A house may be heated from one central furnace much more economically than from as many stoves as there are rooms. If for the ordinary house furnace we substitute a large central furnace, or series of furnaces, equipped with modern labor-saving appliances, and serving a number of houses, the cost of generating the heat is still further reduced, but the expense of distributing it must be met; and pipes must be protected with great care to prevent loss of heat in transmission. Where a large amount of heating is required within a short radius, as for a group of college buildings, central heating may be practised with great advantage.

The same would be true in thickly populated business or residence districts, if all the people within a given radius could be counted on as patrons. Heat from such central stations is distributed as either steam or hot water.

In many towns and cities where central heating stations would be impracticable by themselves, they may be operated as adjuncts to electric lighting stations, the exhaust steam from which may be circulated through a pipe system, or may be used indirectly by heating water. In case the latter plan is followed, the water must be pumped to the various houses or other buildings to be heated. A double pipe system is required for hot water, or at least a pipe circuit or loop, to return the cooled water to the central station.

Steam and hot water heating from central stations has been increasing quite rapidly of late. Gas, aside from natural gas, has been used far more for cooking than for ordinary heating, but its use for heating is becoming more general. Electric heating has not been employed extensively and cannot compete with gas in cheapness. It is as much cleaner than gas as gas is than coal, but far more expensive than gas for the same amount of heat. One thing in favor of both gas and electric heating is that conduits used to convey gas or electricity for lighting may be used to convey it for heating, while heating with hot water or steam adds another set of conduits, and rather large ones, to the many already buried beneath the street surface.

Probably the greatest gain from central heating would be the purer air of houses, stores, and shops which would accompany a reduction of coal dust, soot, and gases due to imperfect combustion. Another boon with either hot water or steam in place of furnace heat would be an atmosphere in winter that had not all the moisture and life scorched out of it. Such heat, it is well known, often contains less moisture than the air breathed in the arid regions, and is very trying to the whole respiratory tract.

THE COLLECTION AND DISPOSAL OF CITY WASTES

CHAPTER XVII

Sewerage and Drainage

Of the various city wastes to be gotten rid of, sewage is the most serious in magnitude and in nuisance-producing and death-dealing possibilities. Its great bulk is due to the general adoption in this country of the water carriage system of removing human excreta, as contrasted with the pail and dry-earth closets sometimes employed in English towns — a system requiring the labor of a small army of men and horses for the collection service. The nuisances incident to sewage when not speedily and promptly removed and treated are caused by the rapid decomposition of the large amount of organic matter which it contains. The grave dangers to health and life which accompany improper sewage disposal may be traced to the fact that sewage is the chief means of spreading typhoid fever, and possibly other ailments, from one person to another.

The first principle of sewerage design is the prompt removal of wastes. To effect this end, a network of pipes, quite as extensive as those of a water-works system, must be provided. After the sewage has been brought to a common point,

the task may be only half accomplished, since a safe and economical plan of disposal must next be devised.

What has been said relating to dry-earth closets should not be construed as condemning them *in toto*, for these may be kept in a thoroughly sanitary condition; but such devices are not in keeping with American habits and spirit, and are quite out of the question where public water supplies are in use, with the high consumption and waste so common to America.

The outdoor sink or privy, and, still worse, the cesspool, serve only to remove human wastes a little distance from living-rooms, and both of them, particularly the latter, are open to the various serious objections so well expressed by the words, "out of sight, out of mind," a condition extremely dangerous in the case of a foe. The invidious feature of leaching privies and cesspools is that they pollute the soil, and, worse yet, the water constantly flowing through the pores of the earth. If, as so generally happens where privies and cesspools are employed, wells are sunk in this polluted soil, sickness and death, sooner or later, are sure to visit the users of water from these wells. Another objection to outside privies is that their semi-publicity, their low temperature in winter, and their inaccessibility in wet weather or at night, tend to irregular habits and thus to derangements of the digestive tract. These factors, particularly the general discomfort and inconvenience of such sanitary make-

shifts, cause the introduction of modern plumbing fixtures within the house, even when recourse must be had to cesspools.

In wet soils cesspools give endless trouble by overflowing. On the other hand, the less trouble of this sort there is, the further may the underground effect of the cesspool extend. Finally, the expense of properly emptying and disinfecting either privies or cesspools would, if capitalized, go far towards meeting the annual charges for a sewerage system.

A revolution in sewerage practice has been brought about by the introduction and rapid extension of the separate system of sewerage, or one network of conduits for the removal of surface water and another for liquid house wastes, or sewage. The first are called storm sewers or drains, and the second are called sanitary sewers. The frequency with which the latter, only, are provided in small cities has developed a tendency to use sanitary sewers and the separate system of sewerage as synonymous terms.

There are many advantages in building sewers on the separate plan. First of all, it permits the postponement of any extensive provision for removing surface water until the house sewage conduits are fairly extended through the community. This is due to the relatively small size and expense of the sanitary sewers, as compared with the huge conduits necessary to carry off the rainfall from large areas. Another important consideration is

the frequent possibility of discharging storm sewers into near-by streams or lakes. This obviates the expense of building large and long outfall sewers. It is made possible by the fact that surface drainage is less dangerous than house sewage, although directly after dry weather, followed by heavy rain, the storm water may be quite as high in organic matter, but not in pathogenic bacteria, as the house sewage. This will depend upon a variety of local conditions, particularly the density of population and the amount of street traffic.

From a sanitary point of view, the separate system of sewers is preferable because it is easier to keep clean. When one set of conduits receives both house wastes and rain water from the streets, it is necessary to make it very large. Rainfall is uncertain both in time and quantity and may occur only at rare intervals. The house sewage, in dry weather, is a mere trickling stream in the bottom of a combined sewer, with insufficient volume and velocity to carry the solid wastes through the sewer to the point of outlet. Foul matter accumulates, decomposes, and generates malodorous gases. These may find their way through manholes and catch-basins into the air above the streets, or through defective plumbing into our houses.

When sewage is to be purified, as is becoming more often the case, the separate system is appreciated as under no other conditions, since the sudden and enormous increase in the volume discharged by combined sewers at every heavy rain

is a very serious tax upon the capacity of the best sewage purification works. Much the same condition exists where the sewage has to be pumped.

In either the separate or combined system, provision may be made for removing the subsoil or ground water. A special line of pipe or underdrain is laid beneath the regular sewer pipe in the separate system. Similar means may be provided in the combined system, although less necessary, since the ground water is pretty likely to find its way through the numerous joints in the masonry of the ordinary brick sewer. The water collected by these underdrains may be discharged into the nearest watercourse, unless more than usually polluted, or unless the stream is used for a domestic water supply. The water collected by subsoil drains, notably in the case of old towns where the ground was formerly honeycombed with privy vaults and cesspools, is often highly polluted. At South Framingham, Mass., this subsoil water, as well as the sewage proper, is purified in order to lessen the danger of polluting the water supply of Boston and the towns in its vicinity. In this same section, too, and also to protect the same water supply, there are several filters for treating the water of streams liable to pollution in passing through villages.

Whether the separate or combined system is adopted, comprehensive plans for the whole city or district should be made at the outset, so the works may be carried out systematically, no matter

how slowly. The practice of allowing private sewers to be built in the public streets, unless in conformity with a well-conceived plan for the whole city, is highly objectionable. It results in bad sanitation, poor economy, and much possible litigation; for when the city comes to put in a thoroughgoing sewerage system, it is liable to find these private sewers so poorly designed and built as to be almost useless, notwithstanding which the owners insist on having them bought by the city, or at least resist an assessment to meet the cost of suitable new sewers. Where private sewers are allowed, provision should be made for ultimate municipal ownership. Such sewers, it is sometimes held, should become the property of the city as soon as it is in a position to care for them. This is not so radical as at first appears, for in many cities the whole cost of sewers is borne by abutting property owners.

Sewerage systems built and maintained on the franchise plan are quite different than the isolated sewer lines just discussed. Such franchises are not often granted, but more of them are in existence than is generally understood.

The very first step in preparing for sewers or drains is to secure an accurate topographical map of the city, showing all the streets, watercourses, hills, valleys, and other physical features, including elevations above an established point generally known as the city datum. Such a map is essential to a vast range of other municipal work besides

sewerage, and the earlier it is made and the more accurate and complete it is, the better. With the aid of such a map, the grades or slopes of various lines of sewers may be established and the possible outlets for the whole system be located.

The sewers should have sufficient fall to give what is known as a self-cleansing velocity; that is, a velocity sufficient to sweep all ordinary solid matters along with the liquid portion of the sewage. Sewers should be lower than cellar bottoms, wherever practicable, in order to provide drainage for cellars and to allow the soil pipe or main vertical pipe from the plumbing fixtures to extend down to the cellar bottom.

All sewers up to a diameter of twenty or twenty-four inches, and sometimes even higher, are commonly built of vitrified clay pipe. Larger sizes are of brick, stone, or concrete, according to such local conditions as the class of material most available, freight rates, nature of the soil, and velocity of the flow through the sewers. In wet ground or ground liable to much settlement, cast-iron pipe may be used. Besides its greater strength, tight joints may be made more readily with iron than with the other materials named. Whatever the material, the greatest care, particularly with small pipe sewers, must be taken to make all the joints tight, for otherwise the ground water may leak into the sewers and so charge them as to render their carrying capacity too small for the sewage. Even if the pipes are not overcharged, the extra volume

will be a serious matter whenever the sewage must be pumped or purified, as many a community has found to its sorrow.

At all changes in horizontal or vertical direction, manholes, or chambers connecting with the street, should be provided to give access to the sewers for inspection and cleaning. Where the sewers have very light grade, and at the upper ends of small sewers having but few connections, provision must be made for admitting large volumes of water to the sewer with suddenness and force, in order to flush or wash out any matter that may have lodged therein. If frequent flushing is necessary, an automatic discharge apparatus, or flush tank, should be used. This is generally a chamber provided with a siphon which is brought into operation as often as may be desired by regulating the size of the stream of water which feeds it.

By perforating the manhole covers a fair amount of ventilation of the sewers may be secured in most well-designed systems. Abroad, special ventilating shafts or flues, varying in height from a few feet to a hundred feet or more, are often employed, but this is very rarely done in America. If the sewers have good grades, are well built, and are flushed as much as is needed, their ventilation should be a simple problem, since there will be little deposit in the sewers and the sewage will pass away before it has time to set up offensive decomposition.

There is no such thing as sewer gas; that is, no

specific gas originating in sewers. Instead, the air in good sewers is not far different from that in the street above. Where sewer air is bad, it is due to a variety of gases given off by decomposing organic matter. Sewer air contains but few bacteria, harmful or otherwise, owing to the fact that these abound in dry dusty air, and not in damp air. The sewage itself contains millions of germs to the teaspoonful, but it is difficult for any of these to get out of the sewage and into the air of the sewer, much less into that of streets or houses. Moreover, such germs as are found in sewer air partake of the nature of those in the street air above.

Combined sewers or storm sewers alone should be provided with catch basins at street intersections and midway in long blocks. The object of these is to admit the surface water from the streets and to retain as much of the street dirt as is possible. This diminishes the chances of stoppage through clogging and decreases operating expenses.

Little has been said about the size of sewers. In either combined or storm water sewers, the chief factor governing size is the amount of rainfall to be removed, but this is greatly modified by the nature of the soil on which it falls and the slope of the surface. Then, too, the intensity and duration of the rainfall must be considered, and also the slope or grade of the sewer; the steeper the grade, the greater the velocity, and therefore

the less the necessary size of the sewers. In closely built areas, particularly those having impervious pavements, sidewalks, and courtyards, comparatively little water can soak into the ground, and thus there is not only a large volume to go to the sewers, but it goes there quickly. All the points named and many others must be studied in the light of local conditions in determining the size of combined sewers.

Fixing the size of sanitary sewers, wholly on the separate plan, is quite another matter. Theoretically, no surface or subsoil water reaches these sewers, but only household liquids or water-borne wastes. Practically, little surface but much subsoil water reaches sanitary sewers, but after all the chief question is the volume of house wastes to be carried away. This determined, it is customary to add an estimated quantity for infiltration (subsoil water leaking or filtering into the sewer pipes). Obviously, the amount of sewage will depend largely upon the amount of water consumption, since in a thoroughly sewered town most of the water consumed reaches the sewers. The chief exceptions are water used in lawn sprinkling and in some industrial plants. The water consumption, as we have seen, is extremely variable. Making allowances for this and for uncertainties as to the amount of infiltration from the subsoil, the amount of sewage to be conveyed by a separate system may be placed at one hundred to one hundred and fifty gallons and upwards per capita. These are rather

indefinite figures, but advisedly so, since it would be folly to try to be at all exact, without opportunity to make a careful study of the various conditions peculiar to each locality.[1]

[1] Among the many treatises on the subject of this chapter the most recent are Folwell's "Sewerage" (New York, fourth edition. 1901) and Ogden's "Sewer Design" (New York, 1899).

CHAPTER XVIII

Sewage Disposal[1]

The introduction of the modern sewerage system has completely altered the methods employed for the disposal of the waste products of the human body, but it has had little effect on the principles involved in their rational treatment. Broadly speaking, there are but two ways of getting rid of this matter: On or into land and into water. One or the other of these methods has been practised ever since the appearance of man upon the earth; and the same is true of the excrementitious wastes of other animals than man. When we consider the volume of organic wastes since the dawn of animal life upon the globe, and the fact that only within recent years has there been any scientific attempt to dispose of the relatively small portion of them produced by men in cities, the stupendous and beneficent task performed by Nature through the centuries becomes apparent. Think of the countless millions of mankind and of lower animals that have carried

[1] This chapter, with the kind permission of the publishers, was read before the annual convention of the League of American Municipalities, Charleston, S.C., Dec. 12, 1900. It has since been altered and extended.

on their life processes, have died and been returned to the dust from which they came, and some slight conception may be gained of the way in which Nature cares for her children. If to animal we add vegetable life, and at the same time remember that wherever organic matter of either class exists it must be speedily transformed into some mineral compound, or breed loathsomeness and possibly death to all the life surrounding it, the wonder is still more increased.

Strange to say, this mighty task of so transforming dead organic matter that it may live again and repeatedly traverse the cycle of existence through millions of years, is not performed by the giants of the universe, but by the tiniest known forms of vegetable life, the bacteria. Through a growing understanding and appreciation of this fact, it has come about that the most promising methods of sewage disposal at the present day are returns to Nature. A few years ago the chief aim in sewage treatment was to kill all bacterial life in sewage; now the supreme effort is to foster and utilize it to the utmost. After the bacteria have played their part in transforming the organic matter in sewage, they, too, make their exit from the stage, without human aid or interference.

Let us see how the methods employed in the disposal of human wastes have changed with the introduction of sewers. First, we may note that the chief constituents of these wastes are carbon, nitrogen, oxygen, and hydrogen, and that it has

been found convenient to study and record the changes involved in the nitrogenous compounds. There are at least three well-marked stages in the transformation of organic wastes to nitrates, or plant food: (1) The separation of the carbonaceous and nitrogenous matter, forming ammonias; (2) the conversion of ammonias into nitrites; (3) the conversion of nitrites into nitrates. The first step is largely a dissolving process, the organic matter being changed from the suspended or solid form to one in solution. During this stage there is little oxygen available, and that is speedily combined with the carbon. The bacteria at work thrive the best without air, and therefore are called anaërobic. Strong gases may be set free during this stage. In the second stage, more oxygen is needed, and aërobic bacteria, or those requiring air for their life processes, begin to supersede the anaërobic. In the final stage, the aërobic bacteria are supreme, and nitrification is completed, hence there must be an abundant supply of oxygen.

Reverting now to the excrementitious wastes of rural life, we find them deposited in small quantities on land or in water, where Nature can dispose of them with ease and without offence or danger to man, provided only that drinking water or food is in no way polluted. With the beginnings of urban life the conditions change somewhat, but not greatly at first, since land is generally plentiful and houses scattered. The first danger to arise is the pollution of wells

located near privy vaults. This may be averted, although it rarely is, by the use of earth closets or like precautions. As houses multiply, the land which hitherto had been capable of receiving the sewage without any offence to the nostrils, becomes overworked and can support only anaërobic bacteria, so foul odors fill the air and outcries against the nuisance arise. By this time the demand for such conveniences as bath tubs and water closets has resulted in the substitution of the cesspool and pipe connections for the outdoor privies, and for the water-soaked and ill-smelling trough through which the liquid wastes from the kitchen were discharged on the surface of the ground. The cesspool is the first step in the evolution of the disposal of house wastes. It simply conceals an unpleasant and dangerous thing. The next step is the change from disposal on or in land to disposal into water, a change which too often is only an attempt to transfer a nuisance from one's own premises to those of a neighbor.

The most marked feature of the change from privies to cesspools, and thence to the water carriage sewerage system, is the vast dilution which the organic matter undergoes. Instead of highly concentrated organic wastes, unsuited for direct use as a fertilizer, we now have some two parts of solid matter, only one of which is organic wastes, to 998 parts of water. At first thought it seems as though this diluted sewage might be discharged into any running stream without offence, but no

greater mistake could be made. Neither may it be discharged in any haphazard manner on land, since so applied all vegetation would soon be killed and a great nuisance would follow.

Fortunately it is possible to discharge sewage into water not used for drinking purposes, or on to land, in such a way that it will be transformed by means of bacteria and oxygen in just as inoffensive a manner as was outlined above for the wastes of an individual or household. The one point to be kept in mind, in either case, is that Nature's laws governing bacterial action must not be violated; and that Nature has her limits and must not be overworked.

These two facts have been realized, although often very imperfectly, in the disposal of sewage on land, but they have been ignored almost universally wherever sewage has been discharged into water. In other words, the latter plan of disposal has almost always been a makeshift, successful, if at all, by accident rather than design. This has confused matters to such an extent that when the public has become aroused, it has gone to the other extreme, crying out against all sewage disposal into water.

It has been claimed as an objection to sewage disposal by dilution that valuable fertilizing material is thus thrown away. It should be remembered, however, that the rivers and ocean support life as truly as the land, and that nothing in Nature is ever lost.

When sewage is discharged directly into water, the burden thereafter is all placed on Nature. If public water supplies, or shellfish used as food, are endangered, disposal by dilution is not permissible; otherwise, the questions to be considered are whether the water is ample to dilute the sewage sufficiently to obviate all danger of a nuisance, and whether the character of the stream or lake and its bed is such that solid matter from the sewage will form objectionable deposits. The exact amount of dilution necessary will depend upon the strength of the sewage and the nature of the stream or lake, and must be determined in each case after careful study of local conditions. Mr. Rudolph Hering has laid down the rule that the volume of water flowing should be at least four cubic feet per second for each one thousand persons tributary to the sewers in question.[1]

The well-warranted and rapidly increasing agitation against water pollution is due to the most shameful abuse of sewage disposal by dilution. Sewage in some cases is actually being discharged into sources of public water supply, or into streams or other bodies in such a way as to create offensive odors and sights. In other words, Nature is being overworked. The excessive quantities of organic impurities in the sewage rob the water of its oxygen, without which the bacteria cannot effect their wonderful transformations. Consequently putrefaction ensues, foul gases are generated, and scum

[1] *Engineering Magazine*, July, 1898.

and grease appear on the surface of the water. When such conditions arise, a new outlet to ampler waters must be provided, or recourse must be had to disposal by land.

When sewage is discharged on land, it cannot be left to its own devices, as is the case when it is turned into water, but every step of the process must be carefully controlled. The theory of sewage disposal on land is based on the fact that particles of sand or soil are teeming with bacterial life, while the spaces between the particles, being filled with air, supply the oxygen necessary to bacterial life and to the chemical changes in sewage — oxidation and nitrification. It must be constantly borne in mind that the liquid portion of sewage, or 998 parts in 1000, must ultimately flow into some body of water. The aim of land disposal is so to reduce the organic matter in the sewage that the latter may be turned into water without danger or offence.

Until quite recently the two chief systems of land disposal were broad irrigation and intermittent filtration. In the former process, also known as sewage farming, small quantities of sewage are applied to land planted or sown to various crops. Naturally, such crops are selected as require large quantities of moisture; but the limitations of even the most water-loving crops render it impossible to apply large quantities of sewage to cultivated lands. Consequently, broad irrigation means broad acres — one acre to every ten to one hundred people.

Sewage farming is successfully practised on a large scale in many European cities, notably Paris and Berlin. It is doubtful, however, if it will ever become popular in this country. It requires many overseers and laborers and a large amount of incidental business in the way of buying supplies and selling products; labor is too high in this country and political mismanagement too much feared. Whatever may be accomplished abroad, we in America could expect as a rule only a reduction in the cost of sewage disposal, not an absolute gain over capital charges and operating expenses.

Owing to a variety of local conditions, and particularly to a lack of suitable land, sewage farming in England for many years past has been supplemented by the use of specially prepared beds of sand, cinders, burnt clay, or other matter on which sewage could be discharged at higher rates. In our own country this process, which is known as intermittent filtration, has been elaborately tested in the exhaustive experiments made by the Massachusetts State Board of Health at Lawrence, and the results verified by actual experience on city filtration areas in Massachusetts and elsewhere. It has been proved that intermittent filtration may be successfully practised on the basis of one acre of land to from two hundred to one thousand people, the amount of land required varying with the strength of the sewage and the character of the soil. In this process a series of filter beds is prepared. The sewage flows continually for a few

hours or days, according as the material is fine or coarse, and is then shut off and the beds allowed to drain. Air thus having been sucked into its pores, the bed remains idle or rests for a time. Meanwhile the sewage is turned on to another bed.

While intermittent filtration requires only one-twentieth the land demanded by sewage farming, the purification of the sewage of a large city by this means would still require more land than most such cities can readily command.

Attempts have been made in both England and America to lighten the burden upon land by the use of some preliminary process which shall remove the bulk of the suspended matter, both mineral and organic. Screening and settling were first tried; the former has been found to accomplish little, though good as far as it goes, and the latter presents many difficulties. Effective sedimentation requires that the sewage shall stand a long time, a process which calls for the construction of costly reservoirs. Worst of all, it may mean offensive decomposition of the suspended matter.

At an early stage in the development of sewage purification chemicals were introduced to hasten sedimentation. They act both as precipitants and antiseptics, throwing down the suspended matter and killing some bacteria. Before the rôle that bacterial life plays in the processes of Nature was as well understood as now, but after the germ theory of disease was generally accepted, chemical precipitation was hailed as a solution of the sewage

problem, because of the reduction of bacterial life that might be effected thereby. Experience soon showed two drawbacks to this process: (1) It removed but little matter in solution, thus leaving about one-half the organic matter in the sewage, which was liable to secondary decomposition and offence later on; and (2) the organic and mineral matters thrown down, together with the chemical used, remained in the bottom of the tank, mixed with about one hundred times its weight of water. At first it was thought that this sludge, as it is called, could be used as a fertilizer; but the large amount of chemicals which it contains, and the fact that it is not directly available as plant food, led to bitter disappointment as to this economy.

Within the past few years studies made in England and America have shown that the old-fashioned cesspool, dangerous as it has been oftentimes, is not wholly bad, and that in those dark and ill-ventilated chambers the anaërobic bacteria have been carrying on their work, unseen and unknown. By changing the form and proportions of the cesspool to an elongated tank, providing preliminary grit chambers for the deposit of sand and other fixed mineral matter, and arranging for the continuous flow of sewage through the tanks at a very low rate, the suspended organic matter has been retained, to be acted on by the anaërobic bacteria at their leisure. Such solid organic matter as has passed on and out with the partially clarified effluent has been either in the dissolved form or in a

finely divided state that will readily dissolve. Under this system the sludge in the septic tank, as this reservoir is called, accumulates very slowly, owing to the fact that so much of the organic matter is changed to gaseous forms, water, and dissolved nitrogenous matter. Consequently the sludge problem, incident to chemical precipitation and more or less troublesome in broad irrigation and intermittent filtration, largely disappears with the septic tank. The effluent from these tanks contains about as much organic matter as that from chemical precipitation works, but in a form much more suitable for further transformation. A little aëration, and it may be passed to filter beds, where aërobic bacteria complete the process.

Without the septic tank, filter beds may be so operated as to result in septic or anaërobic action simply by letting the crude sewage stand on the beds until the anaërobic bacteria have had an opportunity to do their work. After that, the sewage may be passed through a second series of these contact beds and then through a third, if desired, thus securing anaërobic followed by aërobic action.

If the accepted theories of bacterial action are correct, they explain why the so-called contact beds operate so much more rapidly than the intermittent filter beds previously described. By the intermittent process one bed does the whole work of purification and must sustain, first, the anaërobic, and then the aërobic bacteria. The arrangement

of the contact beds is an application to bacterial life of the modern principle of division of labor. The sewage passes from one bed, where the anaërobic bacteria thrive, to a second and perhaps a third, where the aërobic bacteria do their work. This septic sewage possesses the further advantage that its organic matter is in a dissolved form, readily assimilated by life on land or in water.

It is hoped that ultimately this division of bacterial labor may raise sewage farming to the point where so many economists and sanitarians have fancied it, but to which it has rarely, if ever, attained; namely, where all nitrogenous food materials will be returned to the soil.

It should not be inferred from the preceding discussion that because sewage disposal has not attained its full development it is in a more experimental stage than most other branches of the municipal service. The magnitude of the problem, its comparative recentness, and the unwillingness to expend money for purely sanitary matters, which still prevails in most communities, combine to place the status of sewage disposal on a seemingly uncertain basis. The actual conditions are more satisfactory than is generally believed. Sewage farming and intermittent filtration are sufficiently well established to be adopted without danger of failure. As has been pointed out, intermittent filtration is usually better suited to our conditions than broad irrigation. In the West, however, where every drop of water is precious for general irriga-

tion, there seems to be a promising future for the application of sewage to crops. Where intermittent filtration seems to be demanded by local conditions, but suitable land in sufficient quantities is not available, the process may be assisted by sedimentation, by septic tanks and contact beds, or even by the latter alone. The necessity for purely artificial treatment of sewage is greater in England than America, because the sewage is stronger, the streams smaller, and suitable natural filtration areas far more scarce. These facts account for the eagerness with which English engineers and municipalities have attempted to develop septic tanks and contact filter beds. Necessity may compel English communities to adopt methods which through different local conditions would prove unnecessary and unwise in this country.

Before closing this discussion of sewage purification methods, a brief description will be given of the design and construction of the various classes of works. In the preparation of land for broad irrigation little is necessary except to provide channels for distributing the sewage over its surface. Ditches are frequently sufficient, but more permanent conduits, of concrete, brick, or pipe, may be provided for the main channels. Underdrains are generally advisable and may be necessary to prevent the land from becoming soaked with sewage.

For intermittent filtration the land is generally graded to a level surface and divided into beds of an acre or less by means of embankments. Chan-

nels for applying the sewage are provided and tile underdrains, at intervals of twenty to fifty feet, are laid from four to five feet beneath the surface. The sand composing the beds may be either fine or coarse, but should be uniform throughout. A sand of about the fineness used in ordinary mortar gives good results. The sewage is applied to these beds in quantities and at intervals which depend upon the character of the sand, but there is always a period of complete rest between the doses of sewage. This interval gives rise to the term "intermittent filtration."

The contact filter beds are wholly artificial; that is, they are composed of other material than that found *in situ*. Coke or cinders are commonly employed. In other respects their construction does not necessarily differ greatly from intermittent filter beds. Their operation, however, is quite dissimilar, for the contact beds are filled, stand full, are emptied, and then given a resting period. The cycle of the contact beds is repeated two or three times in twenty-four hours. Intermittent beds have periods of rest ranging from a few hours to a day, the working period being equally long.

Septic tanks are built of concrete, brick, or other masonry walls. The original English tanks were tightly covered to exclude both light and air, but it is a question whether or not this is necessary. They are large enough to contain the flow of sewage for from twelve to twenty-four hours.

The most notable examples of broad irrigation are the immense sewage farms of Paris and Berlin, those of each city having an aggregate area of many thousands of acres. Among the best known examples of intermittent filtration in America are the works at South Framingham and Brockton, Massachusetts. Worcester, Massachusetts, and Providence, Rhode Island, have the largest chemical precipitation plants. The septic tank is in use, among other places, at Exeter and Yeovil, England; Barrhead, Scotland; Champaign, Illinois; Marion, Iowa; Independence, Missouri; and Liberty, New York. Septic tanks and contact beds, supplemented by land treatment, have been adopted for Manchester and some other important English towns. The largest place in the United States which has seriously proposed the use of septic tanks is Columbus, Ohio. After various changes in the proposed method of supplementary treatment, the proposition was defeated at the polls. The vote did not necessarily have any bearing upon the merits of the plan, but the previous changes in plan illustrate the attitude of some of the most conservative American sanitarians regarding the newer processes of sewage disposal.[1]

[1] The latest detailed discussion of these processes, but written almost wholly from the English standpoint, is Rideal's "Sewage and the Bacterial Purification of Sewage" (New York, 1900). For earlier general works there may be mentioned Rafter and Baker's "Sewage Disposal in the United States" (New York, 1894) and Baker's "Sewerage and Sewage Purification" (New York, 1896).

CHAPTER XIX

Street Cleaning, Sprinkling, and General Scavenging

Dirty streets are a disgrace to any city. They put an unmistakable stamp upon both the municipal administration and the people back of it. On the other hand, few things contribute more to the good reputation and general well-being of a city than clean streets. They not only add to the comfort and health of the people, but they have a most decided æsthetic value. In our most crowded cities, thousands of children have no other playground than the streets; in fact, throughout large districts, the streets are the only accessible breathing places for both young and old.

There is an intimate relation between street cleaning, street watering, and the removal of ashes, rubbish, and garbage. The cleaner the streets, the less sprinkling will be necessary, but flushing may be desirable to cool pavements in hot weather. Ash and garbage cans, when irregularly removed or carelessly emptied, are in themselves an eyesore and nuisance, and add much to the dirt and litter of the street.[1]

[1] The subject of street dust and dirt is given further consideration in the chapter on "Streets, Pavements, and Sidewalks" and

Street dirt may be gathered by either hand or machine brooms. Where the pavements are smooth, like asphalt, brick, and the best grades of stone blocks, machine sweeping may prove satisfactory, but with rough and uneven pavements hand sweeping is necessary, and even then thorough cleaning is difficult. Machine sweeping is done at night, when the streets are quite free from traffic, thus facilitating the work and lessening the annoyance to those using the streets. Sweeping should be preceded by light sprinkling, to lessen the dust. If the sprinkling is too heavy, mud is formed and the pavement is plastered by it, instead of being cleaned. Obviously, machine brooms cannot be used in wet weather.

Various attempts have been made to devise machines which would both sweep up the dirt and load it into a vehicle, ready to be carted away. Some of these pick-up machines are of the pneumatic type — that is, suction is employed to lift the dirt into a receptacle attached to the machine. When pick-up machines are used, extra wagons must be in attendance to remove the dirt from the machines, since running the machines to the dump would be a loss of time. The ordinary street cleaning machines must be supplemented by hand labor or gutter cleaning machines to sweep the narrow strip of pavement along the curb and gutter.

in the general discussion of city wastes at the opening of the chapter which follows this one.

Hand sweeping may be carried on either by day or night, but preferably at night, except where an attempt is made to keep the streets continually clean, under what is known as the patrol system. When this is attempted, a given length of street is assigned to one man, who is thus made responsible for its condition. He is provided with a can or bag, mounted on two wheels, together with a broad shovel, short broom, and ordinary street cleaner's broom. The use of bags instead of cans was advocated by the late Colonel George E. Waring, who did so much for street cleaning in New York and, by example, throughout the country. The advantage of the bag is that when full it is tied up, left at the curb, and finally removed, thus avoiding the scattering of dust incident to emptying it into a cart. When neither bag nor can is used the dirt is swept into heaps at the curb line. If the wind blows, or there is much traffic, it is likely to be very speedily scattered again, unless promptly removed.

The necessity for cleaning macadamized streets is generally overlooked in this country. Such streets rapidly wear into dust, which should be scraped off and removed at intervals. Otherwise it not only is a nuisance in all sorts of weather, but hastens the wear of the macadam.

The work of removing street dirt after it is gathered is simple enough in itself, but it needs to be conducted in the most systematic and business-like way. First of all, the carts must be water and

dust tight, and must be well covered when not being loaded. The dumps should be so located as to require a minimum haul. The stable and repair departments should receive far more attention than is usually given to them.

Washing or flushing the streets with water is practised largely in Paris and some other European cities. It has been done but rarely in this country. It is considered quite necessary to prevent wooden pavements from becoming intolerably slippery through the mud paste that forms on them under their enormous traffic. There is much to be said in favor of washing such American pavements as asphalt — and brick, when the joints of the brick are filled with a material which will stand it. One of the chief objections to the practice is that all the dirt thus removed goes into the sewers or catch-basins, and in many cases forms deposits which, in turn, must be cleaned out.

In northern climates, more or less snow must be removed from the streets in winter. The chief requisite in removing snow is the rapid organization and handling of a transient force of men and teams. The snow must be dumped at some unobjectionable point, for to dispose of any considerable quantity by melting is out of the question on account of the enormous cost.

The collection of ashes and other house refuse does not differ materially in organization and general methods from the work of carting street dirt.

In the case of garbage, great care must be taken to keep the garbage carts thoroughly clean and inoffensive. This may be effected by washing and by the use of disinfectants and deodorizers. Both garbage and ash carts must be kept covered except when being loaded. For collecting paper and other light rubbish, carts with high sides may be advantageously used. In the ideal system, as explained in the next chapter, garbage, ashes, and light refuse are never mixed. The garbage cans used by householders should be of heavy metal, with covers of the same material, and with iron handles.[1]

Closely related to street cleaning is the watering and sprinkling of streets to keep down the dust. The demands for this service depend much upon the efficiency of street cleaning. Macadamized and dirt streets require frequent sprinkling, if the dust is to be kept down, and as a general rule all other pavements make pretty extensive demands upon this service. Excellent sprinkling carts and special hydrants or stand-pipes to fill them may be bought without difficulty. Good judgment and some skill is required of the sprinkling-cart drivers to distribute just the right amount

[1] Waring's "Street Cleaning" (New York, 1897), the only American book on the subject, relates some of his experiences as commissioner of street cleaning in New York City, and describes some of the methods which he introduced there. It also contains a report by Colonel Waring on street cleaning in Europe, as observed by him in 1896.

of water for the varying needs of different classes of streets.

The majority of small cities and many large ones leave street sprinkling entirely to private initiative; that is, contractors and householders make such arrangements as they can for street sprinkling, and when all the property-holders do not coöperate portions of the street remain dusty. Another practice is for the municipality to control the service, whether or not it does the work, and assess the cost on abutting property-owners. This is an improvement over the other method, but fairness will usually demand that some of the burden be placed on the city as a whole, since such work unavoidably confers a public as well as private benefit. This is particularly true of main thoroughfares.

The collection of garbage, ashes, and light refuse is frequently left to private initiative. But to insure its proper performance, and to make certain that the garbage is collected in the districts where most needed, such work should either be under full municipal control or else be performed by the city itself.

CHAPTER XX

Disposal of Garbage and Other Refuse

In judging of the success or failure of works for the disposal of the various sorts of city refuse, it should be remembered that comparatively few cities, the world over, have yet placed the disposal of the great aggregations of waste materials due to concentrated populations on anything like a scientific basis. These wastes, in order of sanitary importance, are sewage, garbage, street sweepings, stable manure, rags, tin cans, bottles, paper and a great variety of rubbish, including castaways of leather, wood, earthenware, and metal. The proper disposal of sewage is of infinitely greater significance than any of the other materials named, but garbage may become a menace to health through fouling the air or soil during its decomposition, and tin cans and bottles are often so intimately associated with decomposable organic wastes, and so seldom cleansed before being thrown out, that they are liable to give rise to offensive odors.

Street sweepings are objectionable because they contain a considerable amount of organic matter, largely horse manure, and because if not prop-

erly collected and removed they give rise to street dust in dry weather and slime and mud in wet, damaging the eyes and respiratory organs of pedestrians, penetrating houses and places of business with like effect, and increasing the chances of complications from damp feet. Besides these dangers, certain diseases, notably pulmonary tuberculosis or consumption, are disseminated by street dust, and will continue to be until a higher standard of personal decency and public sanitation puts a stop to the filthy and dangerous habit of expectoration on to the streets and the floors of cars, halls, and other public places. The dangers from this source are far greater than is popularly understood, or it would never be tolerated to its present extent, especially from consumptives, most of whom are allowed to and do spread disease germs widecast so long as they are able to go about. From what has been said regarding street dirt, it may be inferred that prompt and proper means for its collection and removal are in some respects more of a problem than its final disposition; for unless mixed with garbage or other readily decomposable matter comparatively little sanitary trouble is experienced with street-sweeping dumps, whether on land or sea. If such dumps are near thickly inhabited areas, or if low lands filled with them are used too soon for building purposes, difficulty or danger may develop.

Stable manure is generally in such demand for fertilizing purposes that its disposal is principally

a matter of sanitary supervision by municipal authorities. Old rags are a menace to health as a vehicle for the spread of certain diseases, but only a fractional percentage of the population of a city is affected by them, principally rag-pickers and sorters and the operators in such factories as utilize them without disinfection. Other classes of light rubbish are even less dangerous, providing they are not contaminated by being mixed with more objectionable wastes.

Ashes, when unmixed with other refuse, are among the cleanest of all city wastes, and in general the most sanitary if kept from the winds. Unfortunately, most cities allow all sorts of more or less decomposed organic matter to be mixed with otherwise clean ashes, but there is now a strong tendency to prohibit this practice.

Garbage cannot, like sewage, be carried away from houses by a concealed underground piping system. Instead, it accumulates in (unnecessarily) malodorous boxes, barrels, or cans, to be scattered by predatory dogs, cats, and rats, until laboriously removed by the city scavenger. This removal is only the beginning of the end of trouble, for, whether deposited on land or water, within any reasonable distance of a city, nuisance is sure to follow. On land, putrefaction, with resultant foul odors, ensues, and on water the lighter portions, including much organic matter, float ashore, and foul beaches which should be clean and popular resorts for health and pleasure.

Burial in the earth disposes of garbage in a perfectly sanitary manner; but an army of men and a whole country-side of land is needed for the purpose where large cities are involved, and land is either too dear or the distance so great as to make the cost of transportation prohibitive. These various causes have each and all operated to compel some of the larger cities to attempt some improved means of garbage disposal, and the movement has been expedited by the belief that incidentally a profit could be made, or at least part of the expense regained, from the grease and fertilizing material in the garbage. Most of the smaller cities, however, have attempted little or nothing in the way of systematic garbage disposal, and this, together with the unsatisfactory achievements in many instances where such attempts have been made, more than justifies the assertion that this branch of city wastes disposal is still on an unscientific basis in most cities.

This deplorable state of affairs is due more to neglect and indifference than lack of knowledge or ability to solve the problems of waste disposal. The questions at issue fall within the domain of engineering, chemistry, biology, finance, and, although an anti-climax, the junk trade.[1]

[1] The preceding portion of this article has been taken from the opening part of an editorial, by the author, which accompanied a description of the Barren Island garbage reduction works, Greater New York, by far the largest garbage disposal plant in the world. See *Engineering News*, February 1, 1900.

In general there are two scientific methods of garbage disposal: burning and reduction. Garbage is burned in various types of furnaces, designed to secure the complete combustion of the gases as well as the solid matter, all at a minimum expense for fuel. As has been mentioned in the chapter on "Light, Heat, and Power," frequent and partially successful attempts to utilize the heat generated in burning garbage have been made in England. The refuse destructors, as these furnaces are named abroad, are called upon to consume a different class of material in England from that found in America. There the percentage of water is far less and of combustible matter is greater than in this country, a fact that is partly due to the custom that prevails of dumping kitchen wastes, ashes and other refuse, indiscriminately into the "dust bin." To a large extent, the English refuse supplies fuel for its own combustion, with the aid of forced draft, while most American furnaces require no little coal or other costly fuel for their operation.

The most serious objection to attempts to utilize the heat from garbage furnaces is the danger of placing the commercial before the sanitary phases of waste disposal. If the boilers are near the fire, as they need to be to utilize the maximum amount of heat, the water in them tends to cool down the fire and thus endanger the complete combustion of the garbage. If the boilers are placed far away, comparatively little heat can be utilized. If the

attempt is to use heat for generating a constant supply of electric current, then the garbage must be supplemented, at times, by other fuel.

We are far behind England in garbage cremation and do not yet know what the best designed and operated furnaces would do under American conditions. Careful observations are needed on the nature of garbage and other refuse, the relative amounts of each material, and the capacity and efficiency of the various furnaces, before deciding definitely what furnace is best for a given city, and whether attempting to utilize heat is practicable. The belief that a profit can be made, under present conditions, by burning American garbage, is an illusion that should be dispelled as soon as possible.

Where refuse other than garbage and ashes is collected, the commercial portion sorted out, and the remainder burned, the process is simple and interesting. The refuse is thrown on to a long, moving endless belt, or inclined elevator, with men and boys ranged on each side. One picks out brown paper, another white, another rags, another metal, and so on. The residue falls into a furnace when the conveyor turns. The heat thus generated is sufficient to drive the elevator and to operate presses for baling the by-products. Besides this there is a possible surplus of heat for other purposes. Such a refuse sorting and burning plant is in use in Boston.

In the reduction process of garbage treatment,

the material from the collecting carts is emptied into upright steel cylinders, about five feet in diameter and fifteen feet high. Here it is cooked with steam under pressure, or subjected to the action of naphtha, or some acid, the object being to extract the grease from the garbage. The grease and water are finally drawn from these digesters into tanks, where the grease rises to the top and is removed for shipment, either with or without some degree of refining. Or if naphtha or some other volatile solvent is used, heat is employed to recover the solvent. The cooked or otherwise treated tankage, or solid matter remaining after drawing off the grease and water, is pressed, then run through mechanical dryers to remove the moisture, then screened, and thus made available as a base for fertilizers. In the best-equipped garbage reduction works exhaust fans and other devices are used to draw all unpleasant odors through scrubbers or to the furnace fire.

No exact figures can be given with regard to the cost of treating garbage in reduction works and the returns from grease and fertilizers, since all such plants are in the hands of private companies. The fact of chief interest to municipalities is that all these companies, or all with experience, demand a very material rate of compensation for treating garbage. Whether the economic advantage is with burning or reducing systems it is hard to say. Small cities and towns must employ cremation rather than reduction, the latter process to be oper-

ated economically requiring a relatively large plant and plenty of garbage.

The location of garbage works of either sort is almost sure to meet with vigorous opposition. Many of the nuisances attributed to garbage disposal are really due to the concentration of garbage carts in the vicinity of the works. When the garbage is removed from the city to some distant point by rail, it is customary to have removable boxes on the garbage wagons. These are simply lifted on to flat cars.

Dead animals may be burned in garbage furnaces, or they may be treated in garbage reduction works, or in rendering works devoted to that very purpose.

If dumping at sea is practised, it is advisable to use self-dumping scows, to save shovelling the garbage. There are few if any examples of dumping at sea that have not met with complaint.

One reason for the unsatisfactory state of garbage disposal in the United States is the failure to recognize that the problem is a technical one, demanding a high grade of engineering knowledge for its solution. Most cities intrust the study of the garbage problem to some council or committee, possessed with no previous knowledge of the subject and with no training which fits its members to gather and weigh information. Such committees generally take a more or less extended tour of inspection of garbage plants in other cities, where they are very likely to be met by commercial

agents of the various systems in use. The outcome often is that the agent who can make the most favorable impression on the committee, by talk, wine, and theatres, has the pleasure and possible profit of having his system adopted. Rightly conducted, these trips may prove instructive and valuable, but, hurried and superficial as they usually are, they are likely to give false impressions. They should always be supplemented by competent engineering advice. The latter might be obtained, in the first instance, with less expense and more certainty of sound conclusions than is likely to be the result of an investigating trip by three to ten laymen.

Another very important factor in the unsatisfactory condition of garbage disposal is the common practice of awarding short term contracts. The investment required for a proper plant is not light in any event, and is quite heavy when reduction is employed. If the term of the contract is short, the contractor must count on one of two things: Getting back the whole cost of the works in a very few years, as well as securing payment for running expenses; or standing on such terms with the city government as to insure a renewal of the contract. In either case he is likely to be chary of spending sufficient money to do the work properly, and the contract price is pretty sure to be high. At present garbage contracts are for periods of from one to five years, with less than three years in the majority

of instances. On such a basis satisfactory service cannot be expected.[1]

[1] Since this chapter was written, the subject of the last two paragraphs has been discussed by the author at greater length in a paper on "The Unsatisfactory Condition of Garbage Disposal in the United States," read before the League of American Municipalities at Jamestown, New York, August 21, 1901. The paper will be found in the proceedings of the convention; also in *Engineering News* for August 21, 1901, and in the *Municipal Journal and Engineer* for October, 1901.

There is no American treatise on the disposal of garbage. The book by the late Colonel Waring, mentioned in the footnote, p. 155, contains a little information on the subject. Of several English books on refuse disposal, the latest and best is Goodrich's "Disposal of Town's Refuse" (London and New York, 1901). It relates almost wholly to the English type of refuse destructors, or furnaces, but has an unsatisfactory chapter on American practice.

CHAPTER XXI

Cemeteries and Crematories

A serious question which confronts the modern municipality, especially the large and rapidly growing city, is the disposal of its human dead. It has been estimated that twenty-four acres are required annually for graves by the city of London. New York, with a population of over 3,000,000 and a mortality rate of 20 per 1000, requires over fifteen acres annually for her dead, even if they are buried at the rate of 4000 bodies per acre.

Many large cities have forbidden further burial within their limits, and their old graveyards are being ruthlessly destroyed. About one hundred graveyards have been destroyed or abandoned in New York since it became a city. London has seized some of her abandoned cemeteries for use as public parks and playgrounds.

A cemetery, then, should be located as far as possible from any thickly populated region, for the double reason that it may not be in the way of the living, and that its dead may remain undisturbed as long as possible. Its soil should be dry and porous, permitting rain and air to penetrate and expedite decomposition. There should be

ample provision for drainage, but care should be taken not to endanger any supply of drinking water thereby. There should be strict regulation as to the distance apart and depth to which graves should be dug.

It is of the utmost importance that full and systematic records of all burials should be kept, so the final resting-place may be proven, if desired, for legal or other purposes. Where cremation is employed, the need of carefully kept and readily authenticated records is even more imperative.

The whole management, if not the absolute ownership of cemeteries, should be in the hands of the municipality. The city of Boston owns or controls many of its cemeteries. In 1897 it created a cemetery department, which consists of a commission of five members appointed by the mayor. In most cities the cemeteries are owned either by the churches or by other private corporations.

So great and inevitable are the difficulties connected with the disposal of the dead by burial that, within the past decade or two, there has been a growing public sentiment in favor of cremation. The objections to burial are both economic and sanitary. The land in and about large cities is too much needed for homes of the living to be perpetually reserved for the forgotten and unbenefited dead. Of more vital importance, however, are the sanitary objections to earth burial. Science has not shown us to what extent the soil,

water, and air are likely to be contaminated by cemeteries. But it is certain that decomposition is inevitable, and that the soil and water, if not the air, may be polluted thereby. There is pretty conclusive evidence that disease germs may live in the bodies of their victims or in the soil, and thence may be conveyed to another human host, but in the light of present knowledge, danger of this sort from any well-regulated cemetery seems remote. Nevertheless, the possibilities of such a result, and the loathsomeness of the processes going on in the thousands of cemeteries throughout the land, may well incline the judicial person, above all the sanitarian, to favor so cleanly a method of disposal as cremation.

Aside from conservatism, the chief obstacles in the way of the general adoption of this method of disposal are sentiment and superstition. Burial being the historic method of Christian disposal, the people, and even the more enlightened clergy, are slow to adopt another system. Many of the most eminent divines of the present day, however, are warm advocates of cremation. Sentimental reasons are hard to understand, for the ultimate fate of the human body must always be the same — decomposition into its original elements. The only choice is as to methods. Shall it be by a slow process of decay and putrefaction that will render it an encumbrance, and possibly a menace to the health of the living, or shall it be by the rapid and purifying agency of fire?

While cremation, as the common method of disposal, must doubtless remain optional for years to come, ought not boards of health to adopt at once the suggestion of Sir Henry Thompson, and make it compulsory in the case of all deaths from communicable diseases, such as smallpox, diphtheria, cholera, typhoid fever, and tuberculosis?

There is one class of human dead, the disposal of whose bodies is within the immediate control of the municipality, and for which incineration seems the only rational method — the city's paupers. The overcrowded condition of the Potter's Field is proverbial. In 1899, Mayor Quincy, of Boston, recommended the erection of a municipal crematory for the incineration of paupers and criminals. The same recommendation was made by the Boston Cemetery Commission. It was stated that the city could cremate bodies at a cost of $1 each, against $3 for burial. The public burials in Boston amount to about five hundred annually, and the Potter's Field is full. In Paris cremation is compulsory for certain classes. In the city crematory are burned all unclaimed hospital dead, remains from dissecting tables, and dead bodies from streets and sewers.

That public sentiment in favor of cremation is growing, is abundantly proved by statistics. At the beginning of 1899 there were twenty-five crematories in the United States, in which 8885 bodies had been incinerated. Previous to 1883 there had been but twenty-five incinerations, all at the crematory at Washington, Pennsylvania. Thus far all the

crematories in this country are owned and operated by private corporations, but with the growth of public sentiment in favor of cremation, especially if made compulsory for certain classes, the public ownership of crematories may become advisable.

No attempt will be made at more than the most general description of the construction and operation of a modern crematory. At Fresh Pond, New York City, a typical crematory has been in operation for fifteen years. The entrance hall is a spacious marble room with niches in the walls for the reception of urns which shall contain the ashes of the dead. In this room funeral services may be held, and an organ service is furnished. The shrouded body is not thrust directly into the flames, but is placed in a fire clay retort. No flames are seen and no odors are present. About three hours are required for the process of incineration. The following day the ashes of the deceased, varying in amount from one and one-half to five pounds, are placed in a black canister, sealed, and kept till the friends of the deceased shall select for them an urn to be placed in a niche in the columbarium, or shall take them away. The coffin is burned separately from the body. The whole service is as little dreary and grewsome as possible, there being no phase, not even placing the body in the retort, that compares with the horror of lowering the coffin into the earth, and hearing the dull thud of the sods, as the grave is filled.

PROTECTION OF LIFE, HEALTH, AND PROPERTY

CHAPTER XXII

Fire Protection

In some respects the human element counts for more in the fire protection service than in any other branch of municipal work. Personal courage, a rare devotion to duty, the keenest perception of just what should be done in an emergency, and the greatest possible mental and physical alertness are among the many qualities required of these public servants, whose lives are risked daily to preserve the lives and property of their fellow-citizens.

There are some communities which cannot, and many others which think they cannot, afford to maintain a paid fire department. The opinions of the latter are rarely based on a scientific study of the facts in the case — a weighing of fire risks and probable yearly losses against the cost of a paid fire department.

Some of the advantages of a paid over a volunteer fire department are better men, better and quicker service, and thus more prompt and efficient control over fires in their early, as well as their later, stages. It is a well-known fact that it is the first few minutes after a fire starts that determines its

magnitude. It stands to reason that men engaged in the ordinary occupations of life cannot get to a fire so quickly nor do so efficient service when there as those who are ready to jump on to the fire apparatus the minute the gong sounds, and who have had years of continuous training and experience. Another factor is that paid fire departments generally include horses as well as men, so when the alarm strikes it is not necessary to wait until the horses can be unhitched from the street sprinkler or road roller and brought to the fire-house before the apparatus can be put in rapid motion.

It almost goes without saying that both men and beasts should have comfortable quarters. Such accommodations are lacking in many cities, even where the fire protection service is otherwise most excellent. Beside providing for the physical comfort and general health of the men, their mental and social welfare should be kept in mind.

Efficiency and character, in this above all city departments, should be the tests that put and keep firemen and their chiefs in office. With these limitations, positions should be for life. If men in any branch of the municipal service ought to be pensioned, certainly firemen should be.

The larger cities have schools for drilling men and horses, and some sort of drill is carried on in most municipalities, but it is often chiefly notable for its inefficiency. The various local, state, and interstate firemen's parades and contests may be made to play a very important part in the spirit

and the results of fire-department work. This fact is not sufficiently appreciated, or more cities would send their chiefs and subordinates to firemen's conventions and tournaments.

The water-supply side of fire protection has been discussed in previous chapters, but even at risk of repetition the two essential features of the service may be mentioned here: Quantity and pressure. Where the natural supply is deficient in either particular, resort must be had to storage and pumping. The latter may be effected by stationary pumps or the ordinary portable fire engines. In either case rapid steaming up is necessary, in order to give prompt and efficient service. Pumps and fire engines, so far as possible, should be provided in duplicate, so one may be in service while the other is laid up for repairs.

When cities are on navigable waters, fire boats are important allies. They can be sent quickly from point to point. By means of powerful pumping engines large high-pressure streams may be thrown from the boats, either through long lines of hose or directly on to near-by fires. For fires on the water front, such as burning docks and warehouses, fire boats may be almost the only means of protection.

A gravity water supply, with large storage reservoirs to draw from and a duplicate line of pipe to bring the water to the centre of the city, is the ideal water-works system. Pumps and fire engines may break down and single pipe lines may fail

during a fire. But the ideal is not always possible, and where the water supply is ample, duplicate force mains and pumping engines may be made to give most admirable fire service.

The gross amount of water used in extinguishing fires forms an insignificant part of the total consumption of most cities, but in the business centres the fire draft for an hour or more is often dangerously near the total capacity of the ordinary water-works plant. Boston, Buffalo, Cleveland, Detroit, and Milwaukee each have fire lines which supply impure water from harbors or rivers by means of fire boats, heavy fire mains, and hydrants. Providence, Rhode Island, has a high-pressure pipe line supplied with water from the same source as the rest of the city to afford extra fire protection for an important section. Rochester, New York, is the most noteworthy instance of a city with a separate supply of impure water for industrial and public purposes. It includes a number of miles of pipe in the business section, and has been in use for many years. Water is pumped from the Genesee River. Of the cities named just above, Boston is the only one making use of salt water for the supplementary supply, but its use has been proposed for New York. Supplementary fire lines which furnish water through permanent mains should not be confused with the use of hose leading from fire boats in rivers or harbors.

Fire hydrants must be so located or marked as to be easily found. They must be kept in good

order, which is next to impossible if any departments or individuals outside the fire department are allowed to use them. Good hose and plenty of it is another most important requisite, but it should be remembered that the friction in hose is far greater and the life of hose much shorter than that of iron pipe, so hose should be used chiefly where portability is essential. Fire hydrants should not be placed more than 528 or 660 feet apart, corresponding to ten and eight to the mile. In crowded localities hydrants should be even nearer together.

Portable fire towers and monitor, or swivel-mounted, fire nozzles are great aids in fighting fires. Searchlights are sometimes used to advantage. The substitution of steam, electric, or other mechanical power for horses is much discussed but little practised.

Systematic records of all facts bearing on the number, origin and duration of fires, losses of life and property, amount and pressure of water used, are of great value to the fire insurance and water-works interests of a city. The volume of water used may be estimated from the number, diameter, and pressure of the fire streams thrown. The pressures are most accurately determined by gauges, a number of which should be permanently located throughout the city. The pressures may be recorded automatically, or they may be read and recorded at intervals by the men on duty at the engine houses. The automatic pressure-recording

gauges afford an almost certain means of settling disputed points as to lack of pressure at fires and the responsibility therefor. They also indicate leaks and stoppages of water and help locate them.

The fire-alarm telegraph is one of the most important adjuncts of the fire department. Its chief, and in fact, almost only cause of failure is negligence or ignorance in maintaining it or in protecting it from damage by the elements and by the powerful electric currents carried by other wires. Relative safety may be afforded by placing the wires underground, in properly insulated water-tight conduits.

Proper building regulations, including restrictions as to outer wooden coverings for the sides and roofs of buildings, will do much to keep down fires. Chimney flues need to be looked after, both in design and in the matter of cleaning. The growing use of electric wires for various purposes adds another fire risk which must be closely watched. Fire-proof construction, inside as well as outside, is also important, particularly in the case of factories and office buildings.

Tall buildings have introduced a new factor in fire protection. When they tower up many stories above the other structures of the city, it may be incumbent on their owners to provide special means of fire protection; that is, the city would furnish an ample supply of water and the owners would install powerful pumping engines and a pipe system within the building.

FIRE PROTECTION

It should be remembered that there is no such thing as a fire-proof building so long as any exposed portion of it is built of wood, and that even if there were the contents of buildings are always somewhat and generally highly inflammable. Nevertheless, with steel framework, brick or stone walls, brick, terra-cotta, or concrete floors and ceilings, non-combustible stairways and elevator shafts, and iron or iron-encased shutters for all windows, the danger from outside fires is greatly diminished. Under such conditions fires originating within the building are generally confined to a single room or floor.

Frequent and searching inspections of all fire risks and thorough investigations of all fires, together with legislation placing more responsibility for fire losses due to carelessness upon property-owners instead of insurance companies, would aid powerfully in cutting down the immense sums that are buried in ashes each year.

CHAPTER XXIII

Building and Plumbing Regulations

One phase of building regulations was discussed in the preceding chapter. Besides protection against loss of life and property through fire, building regulations are designed to guard against bad foundations, weak or otherwise defective walls, columns, beams, girders, and roofs, any or all of which may be due to the use of poor material, scant dimensions, or bad proportions.

Plumbing regulations centre around wash-basins and sinks, bath and laundry tubs, water-closets, the pipes from these fixtures to the street sewers, and the various traps and vent pipes designed to prevent the entrance to living and working rooms of foul air or gases from the plumbing or sewerage systems.

The three chief essentials of sanitary plumbing are simplicity, durability, and air-tightness. Simplicity is put first because it contributes to the other two essentials, through making good work easier and cheaper. The old school of plumbing called for such complexity in the way of traps and vent pipes as to exercise all the ingenuity of the architect and plumber in finding a place for them and

all the capital of the owner in paying for crude material and workmanship. Added to this it was formerly the rule to hide all plumbing as completely as possible, thus robbing the work of accessibility, which might well be termed the fourth essential of good plumbing.

Plenty of air and light should be provided in all apartments containing plumbing fixtures, particularly water-closets and bath-tubs. It is best to have no plumbing in sleeping rooms. The best practice still demands traps on all fixtures, but does not demand that every trap should have a vent pipe running from it to and above the roof. The latter practice adds to the complexity and cost of plumbing, and also to the number of air-leaking joints. The expense thus saved can be put more profitably into a better class of work. The object of trap vents is to prevent the siphoning or emptying of the traps through the suction caused by the sudden rush of water through them. The idea was, that if a column of air was introduced behind the trap, the water in it would be partially balanced thereby. But by using deep and otherwise properly designed traps, it is now believed that the danger of this siphoning is largely, if not wholly, obviated. An argument against trap vents is that the air which they contain tends to evaporate the water from the traps.

Next in sanitary importance to the plumbing already discussed is the gas piping and fitting. In good town and house sewerage work the sew-

age is removed so completely and expeditiously and is so dilute that there is little or no chance for the formation of harmful gases. Gas pipes, on the other hand, are filled with gas which will continuously leak out through defective fittings, joints, or corroded pipes. The deadly effects of inhaling large quantities of illuminating gas are well known, but the deleterious results from continually breathing even small quantities are not sufficiently appreciated. Fortunately tight gas piping and fitting is simply a matter of good material and workmanship, both of which should be insisted on by the municipality.

To insure good plumbing and gas fitting, only licensed plumbers should be allowed to do such work and then not until plans have been filed with the proper municipal authorities. As the work progresses, it should be tested for tightness. Water pressure is applied to ordinary plumbing before the fixtures are set and the smoke or peppermint test to the final work.

The object of plumbing and gas fitting regulations is to prevent the fouling of the air of buildings, but with the best plumbing and gas fitting, a slight contamination of the air from these sources may be expected. In addition, burning gas jets are powerful agents in rendering the air unfit to breathe, since they tend to exhaust the supply of oxygen needed to support life, and load the air with the products of combustion.

All buildings are not lighted by gas, but all with

which this chapter is concerned shelter human beings, who are constantly throwing out from their lungs and the pores of their skin matter which, in sufficient quantities, becomes deadly poison to human and even to animal life. To remove the impurities of the air due to plumbing, gas lighting, human respiration, and numerous other sources, including dust, ventilation should be employed. It is a fit subject for municipal regulation. Probably the fact that health authorities have given more attention to plumbing than to ventilation is due to the popular belief that all sorts of communicable diseases are engendered and spread through defective plumbing and none by means of poor ventilation. Time and science will demonstrate that, harmful as poor plumbing may be, bad ventilation kills its thousands where the death of hundreds is caused by bad plumbing. Good ventilation in itself does much to obviate the evil effects of bad plumbing. Pulmonary tuberculosis, or consumption, as it is popularly called, heads the list of communicable diseases throughout large areas of our country. Both the spread and subsequent development of this disease are largely due to the overbreathed air of dwellings, factories, offices, theatres, churches, and schoolhouses.

Wherever enlightened public sentiment will permit, it should be the aim of municipal authorities to see that every building where human beings live or work is provided with ample facilities for removing foul air and supplying fresh. Either pro-

cess often insures the other. The most praticable plan to this end is wrought out in connection with the heating system, since ventilation and heating are most intimately connected by nature; in fact, they are almost inseparable. In private dwellings, and in many other buildings not frequented by crowds of people, open windows, in summer, and cracks about windows and doors, in winter, provide the necessary interchange between the inner and outer air. The deficiency in winter is more or less fully supplied by using pure out-door air as a circulating medium for artificial heat. As matters now stand, the most that can be done for private houses, offices, and many other buildings of a private or semi-private nature, is to insist on ample fresh-air inlets and channels in connection with the heating arrangements. As buildings take on a more public nature, the municipal regulation of ventilation may become more comprehensive and rigid, until churches, schools, public halls, and theatres are under the closest municipal control. To be sure that this is effective, the provisions for ventilation must be inspected frequently, to see that they are in proper order and in use. The amount of fresh air being supplied, or of foul air exhausted, may sometimes be measured to advantage, and chemical tests for carbon dioxide may be made, using samples of air carefully collected within the buildings.

The amount of fresh air required by each person will vary with his age and occupation and the size

of the room in relation to the number of inmates. It is placed by W. N. Shaw, an English writer, at from "two thousand cubic feet per hour for each healthy child during repose to ninety-eight hundred cubic feet per hour for each adult male in hard work." This assumes continuous occupation of the room and that the carbon dioxide in the room is not allowed to exceed that in the air supplied by more than two parts in ten thousand.[1] One of the latest American books treating of the subject[2] places the amount of air required for good ventilation at 1800 cubic feet per person per hour. It is also stated in this book that the common range of carbon dioxide is from 0.022 per cent "in the purest air to 0.845 in cities and 0.33 in rooms." Expressed in parts per 10,000, the above range is from 2.2 to 33. The same writers state that "a feeling of discomfort is usually experienced if the carbon dioxide accumulates to ten times the normal amount or 40 parts per 10,000 instead of 4." Carbon dioxide, it may be added, is taken as the most convenient indication of the pollution of the air by breathing, rather than because of its own harmful qualities.

Overcrowding is an evil which no practicable amount of ventilation can remedy, particularly as it has other bad phases than polluting the air. It

[1] "Hygiene and Public Health," Stevenson and Murphy, Editors, Philadelphia, 1892.

[2] "Air, Water, and Food," Richards and Woodman, New York, 1900.

is found at its worst in tenement houses, but often exists in the houses of the well-to-do, especially in children's and servants' rooms. It can be lessened by limiting the number of persons who may occupy a room of a given size, but, in some sections, nothing short of a weekly if not a daily inspection would eradicate the evil.

The overcrowding problem suggests a thought that should be kept in mind during all the discussions of ventilation, and of sanitary matters, generally: The education of the individual to higher standards of health is essential to his own well-being and to that of the community. When this is more fully appreciated, it will become less necessary for municipal authorities to regulate ventilation, except in the case of public or semi-public buildings.

Either the municipality or the state should thoroughly and regularly inspect all steam boilers and issue licenses or certificates authorizing the use of the boilers under pressures not to exceed a certain maximum. Passenger and freight elevators, also, should be subject to a rigid periodical inspection by some competent and reliable official or board. Both the elevator and boiler inspection may be left to companies making a specialty of the business, whose certificates are accepted in place of those issued by the city or state authorities. The licensing of stationary engineers and firemen is practised in some states to great advantage and is or may well be extended to elevator operators.

CHAPTER XXIV

Electrolysis of Underground Pipes

Within the past few years, or since the wide extension and use of the electric trolley, a new menace to life and property has arisen. This new agent of destruction, known as electrolysis, is due to the fact that all the current from the motor of the trolley car must return to the power house. In seeking the path of least resistance it often passes through water and gas mains. The numerous joints in these mains are just so many obstacles in the path of the current, and wherever the current leaves the pipes to jump over the obstacle, electrolytic decomposition results. In time, weak spots, then leaks, and finally bad breaks occur as a consequence of this action. In the early history of electric railways such dangers were so little appreciated that no objections were made to connecting the trolley system with the water or gas mains. As years went by, those in charge of water or gas works found to their sorrow that their pipes were being seriously damaged by these return currents, whether reaching the pipes by accident or intention. At first there was a strong tendency on the part of the water and gas men to

try to find some remedy for this evil, but it is now generally agreed that the problem is one for the railway men to solve, and that the only solution is the provision of ample and certain means for the direct return of the current through the street railway system itself. Theoretically, perfect bonding of the rail-ends will suffice. Numerous bonds for that purpose have been patented, but thorough work of this kind is expensive, and the best of bonds are liable to break, through settlement of the track, jars, and other causes. Recently the cast-welded joints, introduced more particularly to make the rails continuous and the track more smooth and firm, have been advocated as a cure for electrolysis. But some of the water-works men who have suffered most from electrolysis insist that nothing short of a second wire will serve to return the current without damage. The objection to this, in the ordinary overhead construction, is that it adds one more to the already confused network of wires, and is particularly troublesome at curves, turnouts, and intersections. Cincinnati is the principal example of the double overhead trolley, in this country. A second wire, overhead or underneath, it is urged, adds very little to the cost of the railway system, when the saving in power is considered. However this may be, certainly there is no justification in equity, whether or not there may be in law, for a method that endangers and increases the cost of the water and gas service of a city, simply to reduce the burdens,

real or apparent, of the street railway service. Several lawsuits are now pending to ascertain upon whom these burdens shall fall. Meanwhile some of the most wide-awake water and gas superintendents are keeping records of all pipes damaged by electrolysis and charging the cost of repairs and renewals to the street railway companies. The water and gas associations are continually discussing the subject and are taking steps to secure state legislation for the protection of the works which they represent. All the street railways in the United States are under private ownership, as are nearly all the gas works. Many of the parties at issue, therefore, are private corporations, but the dangers involved are well within the province of municipal regulation, regardless of the ownership of the gas and water works. Leaks and breaks in water or gas mains imperil life and property, through increased fire risks, damp soil and cellars, and impure air. In addition, there is the expense of repairing mains and service pipes and all the inconvenience and damage due to tearing up the streets to make the repairs in question.

CHAPTER XXV

Smoke Abatement

Whether or not the presence of black smoke in the air is a direct menace to health is a mooted question. The indirect ills which it causes are certain enough. Overhanging smoke shuts out the rays of the sun, especially the blue rays, which are essential to the healthy growth of both plant and animal life. Sunlight is nature's disinfectant and renovator. In its absence the inhabitants, especially the children of a city, are more subject to the attacks of disease and less able to withstand them. A smoky and sooty atmosphere is both a physical and social evil. A condition of the air which is discouraging to personal neatness and renders cleanness of house and streets and the exterior of buildings impossible, must have a distinctly demoralizing effect upon the community. Smoke, like dust, is also the active cause of fogs. Each little grain of carbon acts as a nucleus for the collection of moisture.

Visible smoke is due to the incomplete combustion of fuel. Tiny bits of unconsumed matter are wafted into the air by the gases which are liberated

and not decomposed. Bituminous coal is the chief culprit, and the smoke nuisance, in any city, usually accompanies its use in large quantities.

Three methods of solving the smoke problem have been proposed: (1) The use of only those fuels which do not produce smoke, such as anthracite coal and petroleum; (2) consumption of the smoke; (3) the use of some process which shall insure smokeless combustion of bituminous coal.

The first or prohibitive method is often resorted to and is frequently all that is necessary. This is especially true in the eastern part of the United States, where there is not so great a difference between the cost of hard and soft coal. Oil is generally employed in Russia as a smokeless fuel. Its use has been recommended for America, but it has been pointed out that the available supply is wholly inadequate to meet the demands of our enormous manufacturing industry. The large, new oil wells of Texas may yet have an important bearing on the smoke question in southwestern cities. But the prohibition of the use of soft coal in favor of anthracite is out of the question in some localities and cannot be considered as a permanent solution of the problem anywhere. Soft coal possesses all the necessary qualities of a fuel, being cheap, abundant, easily ignitible, and producing intense heat. Moreover, the anthracite coal fields are restricted both in location and extent.

The second proposed solution of the problem has been the subject of many experiments, resulting in

smoke consumers of varying degrees of efficiency. The inherent difficulties of smoke consumption are so great as to render it probable that this method of abating the smoke nuisance will never be generally adopted. In order to effect combustion it is necessary that all the constituent gases be raised to a very high temperature and mixed with oxygen before the temperature falls. The great volume and rapid motion of the gases, the amount of time and heat necessary to raise them to the required temperature, and the difficulty of thoroughly mixing them with the oxygen, make smoke combustion, by any methods yet devised, impracticable for general use.

We are thus reduced to the third method, or the consumption of any fuel, but particularly bituminous coal, without smoke. It has been shown that with properly constructed furnaces and intelligent firemen, bituminous coal may be used as a fuel without creating a nuisance. The necessary conditions for complete or smokeless combustion of soft coal are: (1) Sufficient supply of air to furnish the necessary oxygen; (2) uniform high temperature of air and gases within the furnace; (3) uniform supply of fuel. These three essentials are effected by having a wider grate surface than in the ordinary furnace; by lifting the boilers farther from the fire, so their cooler surface may not precipitate the carbon into flakes, by arresting its decomposition; and by the use of artificial stokers, instead of firing by hand, thus avoiding

the inrush of cold air which occurs when the furnace door is opened.

Even under the most unfavorable conditions a skilful fireman can do much to prevent the formation of smoke and, on the other hand, with the most improved appliances, a stupid or careless fireman will allow volumes of black smoke to escape from his chimney. Licensing of firemen after an examination to prove their fitness, and the appointment of smoke inspectors, are methods that have been suggested to prevent the evil. Inspection to prevent or reduce smoke has been tried with promising results at Cleveland. The work was placed under the charge of a competent engineer. At the outset the aim was to locate and control the sources of the greatest smoke nuisance. Observations were made from the tops of tall buildings, and the conditions noted were brought to the attention of offenders. The inspectors were always ready to suggest means of reducing the nuisances of which they complained, as well as to help any one seeking them for advice.

It is too early to predict the final outcome of such efforts, but there is reason to believe that, if persistent, they will be of great value. In any community more is to be expected from educational than from compulsory measures.

CHAPTER XXVI

Suppression of Noises

While the city dweller cannot enjoy the absolute quiet any more than the pure air of the country, yet the most serious offences against the sense of hearing, as against the sense of smell, may and should be abolished. Civilized communities are very quick to detect foul odors and to banish their source from the city limits. Discordant sounds, like bad smells, may not be positively injurious to health, but they are an offence to an equally sensitive organ, and as such should be promptly declared a nuisance.

City noises, like most of the ills of life, belong to two general classes — those that can be cured and those that must be endured. To the necessary noises belong the various sounds produced by street traffic. The substitution of asphalt and brick for the rougher paving materials will do much to lessen this class of noises. The use of rubber tires deadens the sound of wagons, and with the use of motor vehicles the incessant hammering of horses' hoofs will be diminished. Improved street car service will remove another series of distracting sounds. Many trolley cars

rock on their springs as they move, producing a maddening noise, while others are unnecessarily noisy on account of poor track or badly worn wheels. The use of subways for street car service will also do much toward producing quieter streets. Hence it is evident that even those noises which, being incidental to street traffic, have been classed as unpreventable may be greatly lessened by the introduction of better pavements and improved means of transportation.

Most of the agencies which make city streets a Babel of conflicting sounds are absolutely unnecessary, and, if public sentiment demanded it, could be readily abolished by the municipal authorities. Chief among these preventable noises are bells and whistles. In these days, when every block contains a public clock and everybody carries a watch, people do not need to be summoned to worship or to work. The churches are in this respect worse offenders than the factories, for while a bell produces a less offensive sound than a steam whistle, it rings oftener and at more unseasonable hours, and is usually closer to the residence section of the city. The postman's earsplitting whistle and the continual hammering of the street car gong are largely unnecessary. With paid fire departments the ringing of fire alarms will be avoided.

Another class of objectionable, and at the same time preventable, noises are those produced by street musicians, pedlers, and hucksters. Still

another class of unnecessary noises is the barking of dogs and howling of cats, which so continually render night hideous. If the tax on dogs were raised and a sufficiently prohibitive tax levied on cats, a blessing would be bestowed on long-suffering humanity.[1]

[1] Two suggestive articles on noise suppression, by John H. Girdner, M.D., have appeared, one in 1896 and one in 1897, in the *North American Review*. To those articles the author is indebted for many of the suggestions in this chapter. Dr. Girdner proposes that societies should be organized in our various cities for the suppression of noises, their aim being both to influence public sentiment and to secure the adoption by city councils of proper ordinances. He also suggests that American cities follow the example of Paris and levy a tax upon pianos.

CHAPTER XXVII

Disinfecting Methods and Apparatus

No other single agent may be made to do so much to prevent the spread of communicable diseases as disinfection. Communicable diseases are spread by means of certain germs or bacteria, originating in the afflicted person and finding a host in some other person. Therefore whenever a communicable disease exists, the resulting germs must be killed instead of being allowed to pass on and find lodgment in another victim. To this end the patient must be isolated as speedily and completely as possible. All emanations from the patient and all articles that have come in contact with him must be disinfected before being taken from the sick room. After the patient leaves the room, through convalescence or death, the apartment and all its contents must be thoroughly disinfected. The first step in this process is to close all holes and cracks in and about the doors and windows. For this purpose adhesive plaster strips are excellent. The room closed, some powerful disinfectant is liberated or generated. For many years the fumes of burning sulphur were considered to be the best disinfectant. Latterly, formaldehyde has come into rapid favor and use.

The gas is generated in the room to be disinfected, either from a specially prepared liquid or solid. It is believed that formaldehyde is a very efficient germicide for surface disinfection, but gaseous disinfectants generally fail to penetrate much if at all below the surface. Anything, therefore, that cannot present a full surface exposure should be given some other treatment or burned. Fumigation of whatever sort may be supplemented by rubbing down walls and ceilings with bread crumbs and washing all woodwork with a suitable disinfecting solution. The bowel discharges and urine of typhoid fever patients should be thoroughly disinfected. The exudate of diphtheria patients and the sputum of consumptives may be placed on cloths and burned immediately. Dishes may be wet with one of the best commercial disinfectants and then kept fifteen minutes in boiling water. Personal and bed linen may be immersed in a solution of carbolic acid and subsequently boiled for at least a half hour. So far as practicable, rugs, carpets, and upholstered furniture should be excluded from the rooms of persons sick with communicable diseases. Such remaining goods of this sort as cannot be disinfected with certainty should be burned.

The difficulty of properly disinfecting certain articles with ordinary appliances suggests the desirability of having municipal disinfecting stations, equipped with apparatus capable of sterilizing all sorts of household goods. The agent commonly

used at these stations is steam. The articles to be treated are placed in air-tight chambers, after which a vacuum may be created and steam admitted under pressure, thus insuring the penetration of all parts of the goods. To avoid the possibility of recontamination, the articles to be sterilized go in at one end of the disinfecting chamber and come out at the other end in an entirely separate room. The air-tight chambers of the disinfecting plant may be used for applying other agents than steam, either with the latter or alone.

Fabrics and wall decorations are subject to little risk of damage from formaldehyde, but may be ruined by some of the other disinfectants, particularly such as require much moisture or are liable to cause chemical changes in coloring materials.

As it is of the utmost importance that disinfection be welcomed rather than resisted, and that no goods be spirited away without treatment, it is well for the municipality to pay for all damages caused by disinfection. The more intelligent classes will realize the value of disinfection as a safeguard to their own families, and there will be few claims for damages. Those few will be confined chiefly to the class of persons least able to bear the loss of bedding and clothing. If a secondary case of diphtheria or scarlet fever occurs in a house that was recently disinfected, a careful investigation should be made to determine whether the man or the method of disinfection employed was at fault.

CHAPTER XXVIII

Prevention of Water Pollution

In the chapters relating to public water supplies and their purification some of the evils of water pollution were indicated, and in the chapter on sewage disposal one means of preventing or lessening the contamination of water was considered. The present chapter deals more particularly with the legal aspects of the case.

For centuries it has been held that all riparian owners have a legal right to the use of the water flowing past them in its natural unpolluted state. As a general rule, whenever a violation of this principle can be proven, the owner can secure relief, either as damages or an injunction against further pollution. In the case of public water supplies, the municipality often has little or no standing as a riparian owner. Its rights in the premises are to divert certain quantities of water, with no further guarantee of purity than may have been conferred by the legislative enabling act, under which a water-supply was developed. As an extreme instance, it has been held by the highest court of the state of New Jersey that the legislature may grant to one city the right to take a public water supply from a river, and subsequently grant to another city the right to discharge sewage

into the same river in such a way as to render the aforesaid water supply utterly unfit for use.[1]

American state legislatures have full power to pass laws prohibiting water pollution, whether or not public water supplies are involved, and they will pass such laws whenever the public demands them. In the thickly populated sections of the country, the action of riparian owners is too uncertain, and the processes of courts too slow to protect the general public against water pollution. In many communities public sanitation is in so backward a state that the people will not rise in their own defence. An epidemic in one locality may endanger many others. For the foregoing and many other reasons it becomes necessary to establish a firm central control over public waters.

The earlier measures for the conservation of the purity of natural water supplies were grants of power to that end made by legislatures to municipal boards of health and councils. About fifteen years ago, Massachusetts led the way by placing the purity of all its inland waters under the general protection of the State Board of Health. A few other states have followed this example more or less closely, including New York and Ohio. In Massachusetts and Ohio, all plans for new water

[1] In a suit involving the right of Paterson to discharge sewage into the Passaic River above the intake of the water-works of Jersey City, decided April 2, 1900: Simmons *vs.* City of Paterson, New Jersey Court of Errors and Appeals (*Atlantic Reporter*, XLV., 995).

or sewage works must be submitted to the respective State Boards of Health for approval, and the same is true for sewerage systems in New York. In New Jersey, there is a State Sewerage Commission with power to hear complaints relating to the pollution of any stream, and to order the nuisance abated within such a period as it may see fit, but in not less than four years. All new schemes for sewage disposal, whether by purification or otherwise, must be approved by the commission before being carried out. Connecticut has a State Sewerage Commission, but its duties are largely advisory. It is probable that the powers of the Connecticut commission will be increased as the value of its actual and possible work is brought home to the people; for the existence of the commission is largely due to the numerous sewage-pollution suits brought in some of the densely populated valleys of the state, and to the able decisions of the judges in favor of the sufferers.

Whether the prevention of water pollution should be intrusted to State Boards of Health, or to separate commissions, is an important question. The work is primarily in the interests of public health, and is closely allied to matters that now occupy a large portion of the time of the boards. Moreover, every well-equipped State Board of Health has its bacteriologist, chemist, and engineer, the very specialists needed by sewerage commissions. The multiplication of commissions is in itself undesirable.

The money required for an effective sewerage commission would generally go much further if intrusted to an existing and partially equipped body like a board of health.

Many streams and lakes involve interstate and international questions of water pollution. The time is coming when these and some of the other sanitary questions must be intrusted to a national board of health. Such a board was created in 1879, but after four years of service Congress refused further appropriations, and its work ceased. A new board has been talked of from time to time since, and would have been created before this were it not for a most unfortunate combination of jealousy between some of the states, between state and national officials, and between some of the departments at Washington.

With the rapid increase in urban population, the growing foulness of rivers and lakes once noted for their purity and beauty, the multiplication of damage and injunction suits, and the never-ceasing demands for more and purer water for municipal supplies, the day for inaction or faltering has passed, and the moment for swift and decisive steps to prevent water pollution has come. Whatever may be the body to whom the work is intrusted, some man or men in each state of the Union should be given authority to pass upon the sanitary phases of all sewage disposal and water-supply schemes, and to guard with jealous care all the waters of the country.

CHAPTER XXIX

Public Baths and Wash-houses

The cities of Europe and Japan are far in advance of American municipalities in the provision which they have made for public baths. The city of Tokio is said to contain one thousand such establishments. Germany is credited with being the first modern city to establish public bathing places, but the first enclosed public baths were built in Liverpool in 1842. Her example was quickly followed by other English cities, till all but seven of the boroughs with more than fifty thousand inhabitants have a system of municipal bath-houses, and many of the smaller cities possess public baths.

In most of the larger continental cities there are municipal bath-houses. In the United States at the close of 1900, not more than a dozen cities had provided themselves with all-the-year-round baths. It is sometimes urged that in this country there is much less need of public baths than abroad on account of the greater prevalence of bath rooms in private homes, and also the larger number of baths operated by the various philanthropic and religious organizations, notably the

Young Men's Christian Association. How fallacious this argument is will be evident from the following statistics.

According to the Seventh Special Report of the United States Commissioner of Labor, the following percentages of the families in four of our largest cities had no bath rooms when the figures were collected in 1894: Baltimore, 98 per cent; Chicago, 97 per cent; New York, 97 per cent; Philadelphia, 83 per cent. Many of these families were living in such crowded quarters that the privacy required for a sponge bath was unobtainable. Such a state of affairs is a menace to the health of the community, for many of our contagious diseases are, like the plagues of ancient times, primarily filth diseases. But the need of general habits of cleanliness on account of the danger of communicable disease is only one phase of the subject. Personal cleanliness is the foundation of all cleanliness and hence one of the most important of civic virtues. A clean body will not tolerate dirty clothing, or a dirty home, or dirty streets. The securing of universal cleanliness would do much to unite the two antagonistic classes and solve the problem of the slums. For after all, it is not their poverty or their ignorance, but their filth which creates the barrier between the very poor and the rest of society.

Baths in the public schools have been recommended by some sanitarians. The first rain baths in public schools were established by Professor

Flügge and Major Merkel of the German University town of Göttingen, in 1885. Boston has a number of successful baths in operation in the Paul Revere School at the north end of the town, and is planning to extend the system to other schools. Much may be said in favor of baths being furnished and made compulsory in certain public schools, while in other localities they would be wholly unnecessary. It will be impossible to secure pure air in many schools, no matter what expensive apparatus is devised for ventilation, until personal cleanliness is compulsory by means of either private or public baths.

Brookline, Massachusetts, has an instructor in swimming. Its swimming class, though not compulsory, is a regular part of the school course. The class is very popular.

Public baths may be made to serve another purpose beside the primary one of fostering bodily cleanliness. They may be made to provide exercise and amusement for the people. In a recent address, Mayor Quincy of Boston pointed out the fact that the American people do not attach sufficient importance to recreation. Probably no form of exercise causes more pleasure or possesses more advantages than swimming. Boys and children take to the water like ducks. The introduction of baths and swimming pools would furnish occupation for that most troublesome portion of our worst classes, the half-grown boys. Already Boston, whose Department of Baths published

its second annual report in 1900, shows evidence of the improved conditions which have followed the inauguration of its very popular system of public baths and gymnasiums. In the opening words of the report: —

"It is the belief of the trustees that the widespread increase of bodily cleanliness and sound physical training, which is resulting from the work of the department, will in due time noticeably advance the general average of public health and order, and in these ways tend to reduce the cost of maintenance in those departments of the city dealing directly with disease, pauperism, and crime. When it is considered that the daily expenses of the city hospital are about $1000 and those of the two houses of correction are about $600, it becomes an important practical question for the city to prevent the causes which lead to the enormous expenses for the city's charitable and penal institutions."

While this country is far behind Europe in the provision of public baths, there has been a general awakening of public sentiment within the last decade. Yonkers was the first American city to establish an all-the-year bath-house at public expense. Boston has now an efficient system of baths, including both open-air summer baths on the water front and all-the-year bath-houses. In 1895, a law was passed in the state of New York providing that all cities having 50,000 or more inhabitants shall establish and maintain such a number of free public baths as the local board of health may deem necessary.[1] Each bath shall be

[1] In addition, the law authorizes any city, village, or town of less than 50,000 inhabitants to provide public bath-houses.

kept open not less than fourteen hours a day, and both hot and cold water shall be provided. In compliance with this statute several cities in the state have provided public bath-houses and others have taken steps in that direction. Buffalo has erected two absolutely free bath-houses. For the four calendar years 1897–1900 a total of 323,942 baths were taken at the first bath-house. The second one was opened on January 2, 1901. The first bath-house in New York City, built under this act, was opened early in 1901. During the following summer an agitation for a number of additional ones was begun.

In choosing the site for a public bath-house great care should be taken to make it readily accessible to the people who need it most. The criticism has been made of the English baths that they are so located and are so luxurious in their appointments that their patrons are chiefly well-to-do people, while the class that the establishments were originally designed to accommodate avoids them. It is a question whether there should not be established in addition to, or instead of, the grand central bath-houses, with their swimming pools and numerous other accessories, many simpler houses, where the people in the immediate neighborhood can easily and frequently take a bath with the object of cleanliness. When a man comes home weary from a day's work, he would not walk a mile, but might step around the corner to rinse off the day's accumulation of dirt.

The desirability of making these institutions readily available to the very poor suggests the question whether any admission fee should be required. It is claimed by some that a slight fee promotes self-respect and appreciation of the baths. Most institutions that require a fee have certain free days in the week. Many admit children free, and others place tickets in the hands of physicians for distribution at their discretion. The Boston bath-houses are absolutely free, although there is a slight charge for a towel, and at the swimming pools for a bathing suit.

The old-fashioned tub or slipper bath is being superseded by the shower or rain bath. The advantages of the shower bath are many and obvious. There is no danger of contamination or infection from the previous occupant. It is a more cleanly method, as there is always a stream of pure water flowing over the bather. There is less danger of taking cold, for a cold shower at the end will close the pores of the skin. The introduction of the shower bath obviates many of the difficulties connected with the introduction of bath rooms in tenement houses. The old-fashioned tub is cumbrous, expensive, and very liable to misuse. The shower bath is not easily put out of order, requires little space, and is economical in the use of water.

In Europe, municipal wash-houses are usually constructed in connection with the baths, though there is a tendency in recent years to operate them

separately. No well-equipped municipal laundries are operated in this country. The Public Baths Association of Philadelphia conducts a wash-house, which has proved very popular. It is so much used by men and boys that two days in the week are set apart for them. It is stated that most of the men who come have but the one suit of underclothing. This they remove, launder, and put on again while they are in the building. At the public bath-house in Rochester, New York, men and boys are allowed to wash their own clothes.[1] For this purpose laundry tubs and a drying closet are provided. In most of the wash-houses women are not allowed to bring their children, although this is permitted in a few institutions.[2] A very important addition to some of the English wash-houses is a public crêche, where mothers may leave their young children to be cared for while they are occupied in the wash-house.

With the general introduction of public bath-houses and the desire for greater cleanliness which they will arouse, the need for public laundries becomes much more urgent. In many a tenement house where the family has but one apartment to serve as sitting room, dining room, kitchen, and laundry, the family wash day and its accompany-

[1] At the first bath-house erected in Buffalo the wash room and drying closet for underclothes was used by 1542 persons in 1897 and 3166 in 1899.

[2] At Buffalo there is an infant's bath room, with porcelain bath tub, for children too young to go under the shower-baths.

ing steam, suds, and confusion is an object of so much dread that it is liable to occur only at infrequent intervals. A public laundry, where, for the cost of the fuel required at home, she may command all the modern conveniences and avoid all the discomfort and confusion of the washing at home, is a great boon to the mother. That it is appreciated as such is proven by the numbers who frequent such establishments as are available.

Public baths and wash-houses are rarely self-supporting. To make them so would probably thwart the primary object of their existence, the betterment of the sanitary condition of the very poor.

CHAPTER XXX

Public Lavatories and Water-closets

No sanitary deficiency of American cities is more noticeable to the person who is familiar with the conveniences furnished by foreign municipalities than the absence of public urinals, water-closets, and lavatories. Except for those which are operated in conjunction with public parks and bath-houses, American cities are practically without these necessities to public comfort. Failure to meet this need is not only a cause of inconvenience and discomfort, but a menace to health and morals. It is well known that in the absence of public conveniences men are forced to patronize saloons and to buy a drink in return for the use of other comforts furnished by the establishment. Policemen, postmen, and other public officials who are forbidden to enter saloons while in uniform, are, in the absence of public water-closets, supplied with not only a very good excuse, but a sufficient reason, for becoming law breakers.

A committee, appointed in 1895 by the mayor of the city of New York to investigate the subject, recommended the introduction of a system of

underground water-closets, such as are now furnished by the city of London and many other European cities. These are clean, inodorous, hidden from view, and attractive, and are generally superseding the old-fashioned and unsightly conveniences. In the London water-closets there is a charge of a penny for the use of closets, and twopence for the use of towels and soap in the lavatory. The urinals and a few seats are free. This small charge renders the institutions well-nigh self-supporting. These underground structures are often placed in the very centre of a crowded street. The roofs are built of pavement glass, and with the narrow strip of sidewalk around them serve the incidental but very useful purpose of a refuge for foot passengers. Underground water-closets are also well adapted for use in parks. The roof, with the exception of the portion required for ventilation, should be kept well below the surface, so there will be room for a healthy sod above, and thus the space taken from the park surface reduced to a minimum. Another location suggested for public water-closets in the largest cities is under the stairways of elevated railway stations. The committee already named, recommended that every policeman's post should include one public comfort station, designed primarily for policemen, sweepers, and other employees of the city, but equally accessible for the general public. Several years after this report was made, underground water-closets were provided in New York, partly beneath small

parks, but with entrances from the sidewalks of crowded streets.

In Boston, the bath department has charge of twelve convenience stations in various parts of the city. The new underground structure on the Common has an average daily attendance of six thousand, which would indicate that many more are needed.

Humble as such stations are, they are proper subjects for careful artistic treatment. In respect to these and other small erections, like newspaper stands, in public places, much may be learned from the municipal supervision exercised by the city of Paris.[1]

[1] See Charles M. Robinson's "The Improvement of Towns and Cities" (New York, 1901).

CHAPTER XXXI

Municipal Dwelling and Lodging Houses

For both sanitary and moral reasons the housing question is one of the most fundamental of the social problems which relate to environment. It is evident that the overcrowding and improper housing of laborers make them weaker physically and less capable of resisting disease, as well as weaker morally and less capable of resisting temptation. This subject has received attention in England for many years. Although a comparatively new question for most American cities, New York is said to be more crowded than any European city.

An exhibit in the year 1900, by the Tenement House Committee of the New York Charity Organization Society, made apparent the fact that there is no place in the world "where the decent poor have so poor a chance to live decently as in New York." Other American cities are also afflicted with overcrowding. More yet are cursed with dwellings that are unsanitary in other respects. It is well known that the death-rate in all such buildings, poorly ventilated, with deficient water supply and defective plumbing, is abnormally high.

The death-rate is but a partial index of the harm done by overcrowding, for the results are moral as well as physical, and there is no death like the death of virtue. Where large fractions of the population are packed together under such conditions that personal cleanliness, modesty, and decency, and even sexual morality, are practically impossible, the problem is one whose speedy solution demands the attention of the moralist and the philanthropist, as well as the sanitarian. The most congested districts are also the domains of drunkenness and other forms of vice.

That private initiative has been insufficient to provide tolerable living quarters for the very poor of a city is proven by the deplorable condition of thousands of tenement houses. Evidently the municipality must grapple with the evil. There are two methods by which it may work. It may adopt stringent regulations to which private tenement proprietors must conform; and it may itself become a landlord.

In this country municipal efforts for the better housing of the poor have all been in the direction of more stringent building regulations. So far as the municipality is concerned, our poor families are allowed to sink to the very depths; then, when municipal shelter is inevitable, they are hustled off to the workhouse. The restrictions thus far attempted have been to limit the height to which buildings can be erected, to prescribe that a certain fraction, usually thirty-five to twenty-five per

cent of the lot, shall not be built upon, to fix a maximum and minimum limit for the size of rooms, forbid the construction of windowless rooms, substitute open courts for air shafts, and open for enclosed stairways. Various sanitary restrictions regarding drains, sinks, water-closets, and bathing facilities are also sometimes insisted upon.

In Europe, several cities have built dwellings. In 1890 the English Housing of the Working Classes Act provided for the demolition by public authorities of houses unfit for human habitation, and, if it were deemed advisable, the erection of new and suitable dwellings upon the areas vacated. The first of these powers has since been granted by the legislatures of New York and Massachusetts. Under the authority of the British Act, London has erected a tenement-house village on the site of the demolished slums, where 6000 people may be accommodated. In 1875 Birmingham purchased about 90 acres of congested territory, upon which stood 1867 dwellings and 814 other buildings. About half of these have been demolished and the remainder put into a sanitary condition. The plan pursued by Birmingham, of destroying only such buildings as cannot at moderate expense be put into sanitary condition, is an excellent one. The wholesale demolition of areas for municipal rebuilding is sometimes wasteful and always capable of abuse. Often municipal ownership, even, is not necessary. Surely, no landlord should be allowed to rent dwellings unfit for hu-

man habitation, and if not permitted to do so the condition of our cities would be vastly improved.

The whole question of demolition of slums is one in which every side and each individual case needs careful consideration. When the object is to provide open spaces or parks, the wholesale ejection of tenants and razing of dwellings may be permissible or even desirable. But when the area is to be rebuilt for the accommodation of the same class of people, the process should be conducted with caution. In all such cases the question must be constantly in mind, what will become of the population that is thus rendered homeless? Will they simply be driven from one district to overcrowd and degrade another? Mere transference of the evil is not real improvement. To better the sanitary condition of one district by making another still worse is a poor policy. One region should not be depopulated until a decent place has been provided for its occupants. In the last analysis the problem is largely mathematical. The greater the number of homes which are financially and geographically available, the less will be the crowding. Simply to tear down buildings is therefore to increase the evil.

The usual mistake in the construction of model tenements, whether by city or philanthropist, is to make them too fine, so their rental is beyond the means of the class that most needs helping. This criticism has been made of the London municipal dwellings. Liverpool tried the experiment of

the cheapest construction consistent with sanitary lighting and plumbing, and made it a success. In these houses rooms are rented at twenty-five cents a week, and it has been found that ninety per cent of their tenants formerly occupied unsanitary buildings. If the city is to embark in tenement-house construction, it should be to meet the needs of these extreme poor who cannot afford to pay more than, say, twenty-five cents a week for a room. Most of the model tenements, it is believed, charge from seventy-five cents to one dollar per week per room. While it has been proven that thoroughly comfortable and sanitary quarters can be provided at this price and realize five per cent on the investment, still this good work does not meet the needs of that large class whose earnings are small, but who may still be kept among the ranks of the self-supporting.

We are therefore driven to the conclusion that while it may be undesirable for the city to engage in the construction of buildings for a class of workmen who could get satisfactory accommodations elsewhere, yet it may be necessary for it to provide homes for the poorest classes, in case careful study should prove their proper construction to be unremunerative to private capital.

The housing of a city's floating population is quite as important as the providing of suitable homes for its permanent inhabitants. The condition of the dwellers in the slums is bad enough at best, but it is rendered infinitely worse by the

presence of a large and ever varying army of "floaters." Only a fraction of this tramp element is sheltered in the wretched lodging houses which private enterprise has supplied. The rest are accommodated in the already overcrowded tenement houses, for it seems an irresistible temptation to their occupants to eke out their slender income by renting every square foot of available floor-space to night lodgers. The tramp element of any community is always its most vicious element. These hordes of night lodgers invade the homes of the very poor, contaminate the whole population, and are the cause of the most serious evils and lawless outbreaks.

The floating tramp population of a city is a permanent factor for which intelligent provision must be made. There must be (1) more stringent regulations against night lodging in private apartments, (2) stricter oversight and control of common lodging houses, (3) municipal lodging houses.

Municipal lodging houses for those who are able to pay a slight charge have been operated in many European cities. In all such matters we are far behind our friends across the water. In the seven municipal lodging houses of Glasgow, 2227 persons are nightly accommodated, each lodger having the use of the kitchen, hot plates, cooking utensils, and dishes. He is given a separate stall or cubicle, which insures entire privacy, a woven wire cot, and clean bed clothes.

The only sleeping place many of our American

cities offer to homeless men is the floor of the police station. New York, after a long struggle, has an admirable free lodging house. Each inmate is treated to a bath, a clean night-shirt, and a clean bed. While he sleeps his clothing is fumigated. The references and record of each lodger are traced back. Habitual vagrants are sent to the workhouse, the sick to the hospitals, and non-residents to their homes. About one in thirty, it is stated, is sent to the workhouse.

In Toledo, a lodging house operated by private charity has an arrangement with the city by which the men, in return for food, bath, and bed, are required to work on the city streets under the direction of the street commissioner. A similar institution in Baltimore is partially supported by public funds.

The first municipal lodging house in the United States was opened in Washington, in 1892. Each lodger is required to saw a certain amount of wood in return for food, bath, and lodging. When this institution was opened, the police station was closed to night lodgers, and, as the work test keeps off professional tramps, the effect is to drive them from the city. The cities of Boston, Massachusetts, and of Syracuse, New York, also operate municipal lodging houses.

CHAPTER XXXII

Municipal Parks, Playgrounds, and Gymnasiums

The function of play in the normal development of children, and the value of recreation in preserving a well-balanced condition among people of all ages, have been little realized or appreciated, even by those who have the welfare of the people most at heart. The foundation principle of the Fröbelian system of education is that it is not in directed study or work, but in play, that the natural faculties are best developed. This principle, in its application to tiny children, has been generally accepted, and the kindergarten is rapidly becoming an essential part of the educational system. But thus far adequate provision has been made only for the babies, while the older children, the youths just maturing into manhood and womanhood, and the grown-ups, weary with the daily struggle for bread, are neglected.

With the spread of broader views concerning what constitutes true education, we shall expect to see our city fathers providing public parks and

playgrounds, and also gymnasiums with skilled instructors, to the end that the young and the old may receive the manifold benefits which such institutions confer.

The recreational value of public baths and swimming pools has already been touched upon. Indoor gymnasiums might conveniently be constructed in connection with the public baths, and open-air gymnasiums in the public playgrounds. Such accommodations for the play of children, ample in size for the tributary juvenile population, should be within a half mile from every home. While it is the influence of play upon the health of the child that appeals to the sanitarian, this is but a small fraction of the sum total of advantages he derives. Children learn best through experience, and it is in play that the child works out the accumulated experience of the race. City children, both rich and poor, have practically no private playgrounds.

Ample playgrounds, especially in the tenement-house sections, have an appreciable effect in lowering the number of minor crimes and misdemeanors of the community. Most juvenile crimes are committed out of mere mischievousness. Nature endows every healthy boy with a fund of energy and spirits which seeks expression in muscular activity.

If no legitimate avenue is provided for the outlet of these animal spirits, some unlawful one is likely to be found. Furnish playgrounds where he

has a right to "let off steam," and a first step has been taken toward transforming the hoodlum into a self-respecting citizen.

Several American cities have already made a beginning toward providing playgrounds for the children. In 1899, Boston had ten playgrounds, and had secured legislation authorizing it to purchase twenty more. Brooklyn has for years maintained a fine but rather inaccessible playground. In 1897, Milwaukee established an open-air gymnasium in one of its parks. Buffalo has playgrounds and open-air gymnasiums combined. Boston maintains both in-door and out-door gymnasiums.

The sanitary value of parks and open-air spaces cannot be too strongly urged. They have been characterized as the lungs of the city. This is not a mere metaphor, for foliage and sunshine purify the air. The air of large cities is, at best, comparatively unhealthful. Even metallic plates and statues are corroded more rapidly in the city than in the country.

It is a mistake to reserve too much of the space in parks to grass and flowers, where the crowds cannot wander freely. The omnipresent warning, "Keep Off the Grass," limits to an intolerable degree the usefulness of many parks. In the park of the Tuileries in Paris, the entire surface that is not occupied by pavements, groups of shrubs, or beds of flowers, is covered with loose gravel. Over this surface the people wander at will. It

is a striking evidence of how parks are appreciated by all, that even where they are frequented by the most disorderly classes, misbehavior is rare.

The water fronts of cities might be utilized in an effective way for the recreation of the people. New York has set the example in this respect by erecting so-called recreation piers, which are simply second stories to the ordinary shipping piers. These are open day and evening during the summer months, and in the evening music and dancing are enjoyed. Philadelphia has also provided a recreation pier in a section of the city where it is greatly appreciated.

Many American cities have made liberal provision for parks within closely built-up areas, and during the last five years a movement to procure public playgrounds has made progress. But there is another class of parks, greater in area than is possible in thickly settled communities, which should be within the reach of their inhabitants. City parks are more or less formal. What is needed in addition is wide areas of wood and meadow, hill and valley, lake and stream, left as nearly as possible in their natural condition. Here the city dweller, on a holiday or Sunday, may wander at will. The advent of the trolley and the bicycle make such reservations accessible, even when several miles distant. Every city should secure such tracts while they are available at comparatively low prices. Improvements may be deferred, but delays in acquisition are dangerous.

The most extended park systems of this kind in the United States are the Metropolitan Park System of Boston and near-by towns, and the Essex County Park System, embracing Newark and adjoining towns in New Jersey. The Metropolitan Park System includes 8090 acres of parks, and about ten miles of driveways, or parkways. The Essex County Park System, at the close of 1898, already covered 2500 acres of land, some of which, located on the ridge and slopes of the Orange Mountain, includes as fine scenery as is to be found in the state. Both of these systems include large reservations selected for the views which they command and their own natural beauty. To such areas little is done by the commissioners in charge, except to make their various parts readily accessible and to cut and plant trees judiciously. The combined holdings of the Metropolitan Commission and the local park boards of Boston and the other towns in the metropolitan district, include a large portion of the river front, besides many miles of ocean beach. On the latter is located a large and handsome bathing establishment. The Essex County Park System will include eventually, it is expected, a number of parkways, some on the Passaic River, others on the mountain crest, and still others joining these and the several parks. New York and other cities have also provided chains of parks and parkways.

The æsthetic side of city parks and squares constitutes one of the chief reasons for their existence.

Beautiful in themselves, when properly selected and developed, they afford rare settings for works of art. But statuary and architecture should be subordinated to the more natural effects, except in the case of public squares designed to set off a public building or monument.

ADMINISTRATION, FINANCE, AND PUBLIC POLICY

CHAPTER XXXIII

City Charters

In no respect has popular government, as it is carried on in the United States, been more criticised than in the conduct of the affairs of cities. It is also true that more genuine effort has been made to improve municipal administration than any other division of government. Our national and state constitutions have gone on with little change in the methods of administration; but our cities have many of them passed through the most kaleidoscopic changes in the organic laws under which they are ruled, and the search for the city charter which shall make good government most easy and misrule most difficult still goes on.

It may be said at the outset that there has been too great a tendency, therefore, to believe that some particular type of charter or form of administration is the cure-all for our municipal evils, and that faults for which the whole body politic is responsible can be remedied by the intervention of a few reformers in the halls of the state legislature. Men are always more important than methods; good men and a bad charter are to be preferred to the best of charters in the hands of ignorant or vicious officials. Most cities have already received

from their state legislatures far more comprehensive powers than they have attempted to utilize. Nevertheless, the most able and conscientious city officials are hampered by poor charters, and men of less ability and honesty are still more unlikely to serve the city well under such instruments. It will be sufficient for the purposes of this chapter to discuss a few of the fundamental principles of city charters, particularly those which most affect the engineer and sanitarian and the classes of public works intrusted to them.

Under ideal conditions each municipality would be left to govern itself in accordance with its own ideas, except in those matters affecting the state as a whole, such as the protection of life and property. It is not easy, however, to determine where the exceptions stop, although much more power might safely be given a city than is embodied in the average charter. Whatever the city charter may or may not contain, it should be so drawn as to insure the greatest possible measure of municipal home rule, or freedom from that bane of city government — legislative interference. Unquestionably, the meddling of state legislatures in purely local affairs is one of the greatest evils of municipal government in the United States. This seems the more strange when we remember that it affects a large proportion of the people of a nation, which, in its earliest history, fought desperately for the widest measure of local self-government.

Municipal home rule can be attained by confining the charter to fundamental principles, instead of including a mass of legislative details, and by providing some form of state control through boards or commissions, over such matters as health work, quasi-public corporations, and municipal accounting. The advantage of central administrative control is that, under it, the legislature may establish broad general principles as to the powers and duties of municipalities, leaving the latter to work out the details, subject to the approval of the central board. The latter must guard the interests of both the city and the state. It should be composed of able specialists. Under such an arrangement special legislation would not be required, as is often the case under the present régime, before a city can let a contract for the erection of a garbage disposal plant, nor would legislative sanction be required for each new bond issue or for some change in the powers or duties of the city engineer.

In minor matters and in many important ones, as well, municipalities should be free to work out their own salvation. But where plans or methods, largely experimental in character, involve life and property, they may well be subjected to central control.

A limit should be placed on bonded indebtedness and taxation. It is urged by some that between bonds issued to pay the expense of constructing revenue-producing, and non-revenue-producing public works, a distinction should be made;

that the former should be omitted in summing up a city's indebtedness to see whether it has reached the limit fixed by law. In some cities water-works bonds are already excluded.

Faithful public servants should be protected by proper civil service regulations. The interests of people and of investors should be guarded by laying down with more care and definiteness than heretofore a few of the principles governing all municipal franchises. Finally, but by no means of least importance, the legislative and executive functions of government should be more clearly differentiated, particularly where they affect the construction and operation of the many great public works so essential to the modern city.[1]

[1] No consideration of this subject would be complete that did not mention the admirable "Municipal Program" formulated by a committee of the National Municipal League (see Proceedings 1898 and 1899). This Program includes an outline for a model city charter which the present author has previously characterized as one of the best pieces of constructive work ever accomplished in the history of municipal affairs. The Program is supplemented by a number of valuable explanatory and critical papers. It has been published separately (The Macmillan Co., 1900). The author reviewed the Program at length in *Engineering News* of December 1, 1898. Two highly instructive books on municipal government in general have been written by Frank Goodnow. They are entitled "Municipal Home Rule" and "Municipal Problems." Another book which contains valuable suggestions is the "Study of Municipal Government," by Delos F. Wilcox.

CHAPTER XXXIV

Municipal Experts and Specialists

The word expert has been so badly overworked, particularly when associated with testimony in legal cases, that one hesitates to use it lest a laugh should be raised where serious consideration is needed. But both the word and the class of men designated by it have their proper place in municipal affairs. In fact, the complex activities of the municipality of the twentieth century will raise the specialist in engineering, sanitation, law, and art to a place never before realized. No one executive officer can keep abreast of all the advances in any of the municipal departments, unless that department be limited indeed. In the larger cities specialists must be employed constantly within the several departments. In the smaller cities their services will be required whenever unusual problems arise. In cities great and small experts of broad and varied experience, free from departmental ruts and superior to all local customs and prejudices, must be called in from time to time if the highest possibilities are to be attained at a minimum cost. This principle has been recognized in a few lines of municipal work,

such as sewerage and water supply. It needs to be extended to paving, garbage disposal, fire departments, central lighting and heating, municipal accounting, and many other subjects just beginning to receive serious attention.

The need of expert advice has been emphasized so often, in the discussions of the different chapters, that it calls for little comment here. There is, however, one humble branch of municipal service where the need of expert advice is so great and so little understood, that at the risk of repetition, it will be again referred to, namely, garbage disposal. The most improved modern systems of treating garbage involve problems in civil and mechanical engineering which only a specially trained man can solve in a thoroughly economic and sanitary manner. If garbage is to be burned to the best advantage, the amount of heat required and the best means of applying it must be determined in accordance with the peculiar local conditions of each case. In addition, the possibility of utilizing the heat of combustion for developing electricity or some other useful form of energy should be considered. When attempts are made to recover grease and fertilizing material from garbage, the problems are even more difficult and the need of special engineering advice correspondingly greater. Failure to procure such advice accounts, in large measure, for the many unsuccessful garbage furnaces which have been abandoned or are still white elephants on the hands of the municipalities using them. A

pumping engine or a filter plant is not provided in such a haphazard manner, simply because the magnitude of the problem and the ignorance (which in such matters is not at all blameworthy) of city councilmen is apparent to those gentlemen; but the disposal of garbage or swill is held to be such an elementary matter that any committee of councilmen can solve the problem after seeing a few plants in operation.

The foregoing is a very homely illustration of the principles running through most departments and branches of city government. Happily the day is coming when a far-reaching change will occur. First, permanent and well-paid technical men will be put in charge of all technical work, and next or parallel with it, the most experienced specialists of the country will be called in to aid in the construction and testing of all public works, and to advise from time to time regarding the best mode of operation.

CHAPTER XXXV

The Departments of Public Works and Engineering

In striking contrast to the practice in England, the development of municipal works in the United States has been intrusted very largely to special commissions instead of being left to city councils. In a majority of cases these commissions are quite independent of all other branches of the city government, except in the matter of raising money for their expenses. Even this limit is frequently absent. Of the many factors which have entered into the production of this state of affairs the two most potent have been: (1) Popular distrust of the city council; (2) the technical character of the specific problems to be solved. These problems have seemed to demand that they be intrusted to a few men chosen on account of their special fitness for the task, rather than to a large body, brought together by the accident or design of party politics to look after a great variety of municipal interests. Just why the taxpayers and business men of our cities have so freely resorted to these special boards instead of reforming the city councils is an interesting question which will not be discussed here,

further than to say that the course pursued has seemed to be easier, and to promise greater permanence in the personnel of the administration and in the policy to be pursued.

More fundamental than either of the reasons named has been the general failure of our municipalities to provide themselves with a high grade of permanent heads of executive departments. An English city council can administer a great variety of important public works, because it places and keeps able and experienced men in executive positions. While, in the English journals devoted to municipal affairs, allegations are often made that men are appointed to office because they are relatives or favorites of some councilman, the accusation that appointments are made in payment of party obligations is rarely seen.

The appointment of special boards, possessed of legislative as well as executive functions, often with powers to create indebtedness, raises the question of the advisability of vesting legislative authority in any body outside the city council. Theoretically the practice seems undesirable. It is undemocratic when granted to a board not elected by the people, especially when such a board can raise money by taxation. In many cases it tends to a divided responsibility. But where independent boards are created because city councils are believed to be incompetent or dishonest, the object sought may be defeated unless the board is, in money matters also, independent of the council. A check on the

board may be had by giving the mayor the power of removal for non-fulfilment of duty or betrayal of trust.

The composition of municipal commissions, as to numbers and qualifications of membership, should depend largely upon whether or not they have legislative functions, and also upon the degree of specialization that prevails. If legislative functions are to be performed, there is much more reason for having a commission of several members rather than a single commissioner. This is likewise true if the board has charge of many different interests, as water supply, sewerage, street cleaning, garbage disposal, and public lighting, instead of only one of these departments. On the other hand, prompt action, the easy fixing of responsibility, and freedom from party politics are more likely to result where there is a single commissioner. The more purely executive is the work in hand, the greater the reason for intrusting it to a single commissioner. One thing is certain, large commissions should be avoided. Five men will almost universally accomplish better results than seven, and generally three are preferable to five. The great sewerage and water-supply systems for Boston and vicinity are being most satisfactorily conducted by three-men commissions.[1] It is a well-known fact that the chairmen of most commissions do the bulk of the work, the other

[1] In 1901 these two commissions were replaced by a single one with three members.

members simply accepting or rejecting the conclusions.

There is much to be said in favor of placing in the hands of a single commission the management of all classes of public works, or at least everything which involves the continuous use of the city streets. This plan tends to a harmonious development of all classes of municipal work, and lessens the danger that one branch of service will be crippled, because an undue proportion of the available funds of the city is going in some other direction. The control of private corporations is essential if street pavements are to be preserved, if underground pipes are to be protected from the ravages of electrolysis, and if other public works are to be insured against accident or damage.

Where separate commissions control the different departments, as water supply, sewerage, and paving, their activities may be harmonized to some extent by requiring them to pass jointly on such matters as affect two or more departments. The plan has been successfully tried in some cities, notably in St. Louis, Missouri, where the commissioner of water supply, commissioner of sewers, and other heads of departments form the board of public improvements.

Passing now to the qualifications for membership on these municipal boards, the first essential, after assuming honesty and good intentions, is executive ability. Technical training is always advantageous, but the commission must be provided

with a technical staff in any event, and must depend upon it for the design and execution of public works. If the commission contains several members, it will be a most excellent plan to place an engineer on the board, though he is scarcely more needed than a lawyer. The city will require well-paid engineering and legal advisers, without regard to the membership of any of its commissions.

As to the engineering staff, the same general questions relating to its scope arise as have been raised in discussing commissions. But a single city engineer may serve a city well, even where there are several commissions. A strong central engineering staff will be more effective than a separate engineer in the direct service of each department. Indeed, the various classes of municipal engineering are so inter-related that a single engineering department may prove more beneficial than a comprehensive board of works.

It must be remembered, however, that engineering has become a highly developed profession, with much specialization, particularly in the municipal field. Thus there are not only water, sewerage, paving, gas and electric lighting engineers, but in many of these divisions there are several specialists. In the department of water supply, there are specialists in the development of the water itself, in the building of dams, the design, construction and testing of pumping machinery, the purification of water, and the planning of distribution systems. This, perhaps, is an extreme case,

but it serves to illustrate the complexity of the engineering problems of the twentieth century municipality. In a city of any size no one can go far into the details of all the engineering branches, but it is highly desirable that a single engineer shall supervise all the engineering work. It is a prime essential that such an official be a man of executive ability. This is quite different from the popular idea of a city engineer, which pictures him as a mere measurer and calculator, a conception based on the work of the old-time surveyor who laid out town lots.

The manner in which the membership of commissions should be selected will depend somewhat on the scope of their duties. If they perform legislative functions, there is some reason for their election by popular vote, though there is always the danger that the nominations, being made by political bosses, will not be of so high a character as appointments by a mayor, directly responsible for their character. Generally the activities are more executive than legislative, so the members may well be appointed by the mayor. The duties of such boards relate so much to technical matters that it is better to have them appointed by some one man who is likely to feel the responsibility of making wise selections, rather than to leave the choice to the whole voting population or even to the city council.

City engineers should never be elected by popular vote, and it is rarely desirable to have them

appointed by a city council. Engineers who are subject to commissions may be appointed by the same, but generally speaking chief engineers should be allowed to select their assistants, under civil service rules. In no case should assistants be forced on a city engineer by the city council or any other branch of city government. His work involves the expenditure of large sums of money and often concerns many thousands of human lives. Carelessness and ignorance are criminal. They cannot be avoided unless the securing and retaining of good men is possible, which is not the case where politics or favoritism governs the selection of assistants.

Besides the engineering subordinates, there must be an adequate force of inspectors, foremen, and clerks. Many of the inspectors must be engineers, and more of them might well be. It is essential that they be under the civil service and merit system, since the character and cost of all public work depends largely upon the capacity and fidelity of the inspectors.

Good men cannot be secured, much less retained, unless they are well paid. Private corporations realize this more fully than municipalities, and take away many an engineer soon after he begins to do good work for a city.

Aside from the regular engineering staff of a city, experts must be called in to help solve special problems from time to time. They save cities their fees many times over.

A well-devised and carefully kept system of records is an essential feature of the departments of public works and engineering. The lack of such records is one of the greatest drawbacks to municipal progress. Without them neither the cost of public service nor the results obtained can be known. This is gradually being learned in many cities, particularly in the engineering departments. An improvement in these records will be one of the features of the present century.

CHAPTER XXXVI

The Work of Boards of Health

The preservation of life and health is the one grand object of boards of health.[1] This aim is to be achieved by preventive rather than remedial measures. The causes of ill health are to be lessened and removed, leaving the cure of such ailments as arise from lack of public vigilance, private care, and uncontrollable causes, to the doctor and the nurse.

The two great forces on which public health work depends are education and the police power. Many of our states have placed almost unbounded police power in local boards of health, but the educative feature of the work of these boards depends upon the character of their membership. The extent to which either the police or educative functions may be exercised is largely dependent upon the state of public opinion. Of course there are certain classes in every community which can be reached and held only by the strong arm of the law, and these will sometimes elude the vigilance of the best boards of health.

Health boards may accomplish much by taking the public into their confidence, and thus securing

coöperation instead of opposition. This is particularly true of those portions of the public that supply some of the various wants of the community, like milkmen and plumbers. It is also true of doctors, some of whom occasion progressive boards of health more difficulty than is caused by men in any other calling. But if the plumber and the doctor can be convinced that the board of health is really seeking his aid and is working wholly in the interests of public health, and that those interests are mutual, more than half of the battle will have been fought and won. At least such has been the experience of the author, as a member, for many years, of a board of health, in a small, but progressive suburban town. Besides the purveyors of water, milk, and other foods, and the plumbers, doctors, midwives, and clergymen, most of the relations between boards of health and the public are due to various nuisances caused by unsanitary domestic conditions, and to quarantine and disinfection for communicable diseases. Good feeling and success, which so often go hand in hand, depend very largely upon the tact of the local health inspector.

In most localities, the first work of a new or reorganized board of health will be to adopt a sanitary code, or a series of health ordinances. While the general powers of local boards often enable them to proceed against any nuisance or menace to the public health, yet for the guidance of both the board and the public, and for the better standing

of the board in the courts, it is safer and more reasonable to formally declare what does constitute such a nuisance or menace. Many a board of health has lost what would have been a clear case in court, because it had failed to make proper regulations on the question in litigation.

The drafting of a sanitary code or health ordinance demands the services of (1) a man well trained in sanitation and what may be termed preventive public medicine, and (2) an experienced lawyer, familiar with the general laws of the state and the court decisions bearing on the same. The first will tell what is to be prohibited and regulated, and the nature of the regulation; the second will throw the whole into proper legal form, so the ordinance may be enforced in the courts, if necessary. The best health ordinance must be enforced to be respected. To this end there should be no hesitation in bringing violators to the bench.

Among a host of other things, a good health code will prohibit the sale of adulterated, contaminated, or decomposing food, including meat or milk from diseased animals. It will prohibit the pollution of the air, the water, and the soil in such a manner as to menace public health. To that end it will contain regulations for the plumbing, gas fitting, heating, and ventilation of buildings and the disposal of organic wastes. It will require physicians to report all communicable diseases, not omitting tuberculosis. It will require clergy-

men and others performing marriage ceremonies to report marriages, doctors and midwives to report births, undertakers to secure burial certificates, and those in charge of cemeteries and crematories to refuse burial or burning without certificates. It will require the placarding of houses in which there are cases of communicable disease, the isolation of the patients within some room of the house, the quarantining of the houses, if deemed necessary, and their disinfection on the recovery or death of the patients.

The efficient health board will, through frequent house to house inspection and a complete but flexible system of records, know the present condition and past sanitary history of every habitation within its jurisdiction. It will abate nuisances as they arise and guard against their future occurrence. It will frequently inspect all establishments where meat, vegetables, milk, and foods are for sale, examine all dairies, barns, milk-houses and their appurtenances, from which milk is brought into the town or city. It will ever be on the alert to detect and ward off any possible source of disease or ill health, always acting on the good old maxim that "an ounce of prevention is worth a pound of cure."

Two new and promising lines of health board work are the suppression of flies, on account of their part in the spread of typhoid fever, and the reduction of mosquitoes, because of their probable relation to both malaria and yellow fever. Much

may be done to keep down house flies, by not allowing large accumulations of garbage, stable manure, or human excreta, near houses or towns, and by disinfecting or covering with fresh earth such accumulations as are unavoidable. Draining or filling stagnant pools of water, and where this is impossible, spreading a thin film of kerosene oil over the water, will greatly reduce the mosquito plague. Flies, it may be added, convey typhoid and other disease germs, on their feet or body, through coming in contact with infected material and then with food for human consumption. The chief danger of typhoid infection by means of flies is in towns where open privy vaults have not given way to more improved means of waste disposal. Mosquitoes are supposed to disseminate malaria and yellow fever by biting, in turn, persons suffering with, and free from, the disease.[1]

The significance of the board of health has scarcely begun to be appreciated by most American cities. When its true position in municipal life is perceived, it will rise to a dignity and usefulness scarcely dreamed of at the beginning of the twentieth century. As that position becomes established, the need for its work might be expected to be diminished, were it not for the fact that each

[1] See "Abstract of Report on the Origin and Spread of Typhoid Fever in U. S. Military Camps during the Spanish War of 1898," by Majors Reed, U. S. A., and Vaughan and Shakespeare, U. S. V. (Washington, 1900); also Howard's "Mosquitoes" (New York, 1901).

advancement in the condition of man presents new aims for the future. The present ravages of disease, together with the comparatively slow progress of preventive medicine in the past, give little hope of relief from the necessity of continued strenuous activity on the part of boards of health. Unfortunately many municipalities have no boards of health, and hundreds of the boards which exist are weak and ineffective.

Turning alike from the bright and from the dark side of this outlook, let us consider briefly the desirable factors in the composition of local boards of health and their executive staff.

The guardians of the public health should be independent of city councils in membership and authority, partly so in the matter of appropriations, and wholly so in the details of expenditure and the engagement and discharge of employees on their working staff. As to appropriations, it may be explained that it is a common and highly desirable practice in some of the most advanced states for the legislature to authorize expenditures by boards of health up to a certain percentage of the assessed valuation of property taxed, in order that the boards may be assured of some money for their work. In addition, all local boards should be, as many already are, empowered to incur extra indebtedness to suppress epidemics.

The popular idea that boards of health must be composed wholly of physicians should give place to a more rational conception of the work of such

boards, and the qualifications for membership upon them. As long as the chief function of boards of health was to quarantine cases of communicable disease and to order a general cleaning up of foul back yards whenever an epidemic arose or was threatened, and when doctors were practically the only men in the community who had even a partial conception of the natural laws of public health, it is not surprising that health boards were composed of physicians. But health protective work to-day rests on a broader and deeper foundation; and the bacteriologist, the chemist, the engineer, the intelligent school principal, and a growing body of laymen understand the need of health protection and the methods necessary to that end, quite as fully as the physician, while their grasp of the subject is often more comprehensive and more in accord with modern ideas. Naturally it is the older physicians who are farthest behind the times in matters relating to public health; men who received their education before bacteriological science was developed, when the filtration of water was supposed to be nothing but a straining process; when a specific compound called sewer gas was supposed to exist, and in some mysterious way to give rise to diphtheria and a whole Pandora's box of other ills; when complexity and concealment were the rule in plumbing work, instead of simplicity, visibility, and accessibility; and when typhoid and scarlet fever were credited with springing *de novo* from a neglected garbage can or refuse heap. The

true conception of most of these sanitary matters has been gained in the fields of bacteriology, chemistry, and engineering. The older medical practitioners are generally too busy to do more than keep well abreast of the advances in pure medicine and surgery, and the medical schools are only beginning to ground their students firmly in the principles of sanitation. It must be remembered, also, that the work of the efficient board of health clashes oftener with the selfish interests of physicians than with men of almost any other profession or trade, and that the younger doctors, in their desire to do nothing to hinder the building up of a large practice, may be sorely tempted to let public welfare give way to private interests.

All this is not designed to be an argument for excluding doctors from boards of health, but merely as a warning against excluding every one else. No municipal board, particularly when possessed of legislative, judicial, and executive functions, as health boards generally are, should be made up of men from a single profession or trade. Boards of health should have neither doctors, plumbers, milkmen, engineers, or lawyers in the majority; in other words, no single class should predominate, particularly a class more or less under the supervision of the board and having extensive sanitary relations with the public. The ideal board would include a doctor or two, a sanitary engineer, a lawyer, a business man, and possibly a plumber, although a properly qualified

man from the last-named class would be the most difficult to secure in nearly all cities and towns.

It should not be supposed, however, that the members from any of the professions or trades are to assume the duties or materially lessen the necessity of employing a city physician, a sanitary inspector, and an attorney.

The chief executive officer of a board of health should be a man well educated for, and experienced in, his duties, with great tact, unlimited resources, and untiring devotion to the responsibilities and opportunities of his profession. Although he may, with some advantage, be a physician by education, provided he have the other training necessary for his office, he should rarely be a practising physician, unless in small towns, where it would be impossible otherwise to get a man in any degree fitted for the office. The day will come when prospective health officers will pursue courses in our universities and technical schools, designed to fit them for the work, and when these men will not be eligible for office until they can show a certificate of graduation from such a course, or of successful examination before some state board intrusted with the performance of that duty. Already a few of our best technical schools offer such instruction. Rutgers College, at New Brunswick, New Jersey, through coöperation with the State Board of Health, has provided an unofficial board for voluntary examination for certificates as to fitness for the office of health inspector. The

courses in sanitary engineering given in many of our best technical schools lay a good foundation for the work of sanitary inspectors and engineers to boards of health, but they generally lack in chemical and biological work, and in training in vital statistics. They also fail to give adequate instruction in economics and sociology, a fair knowledge of which is of great advantage to the health officer.

In the larger cities, the work of boards of health is, or should be, sufficiently extensive and varied to demand the services of at least one engineer, one chemist, and one bacteriologist, if not a staff of each. There is little lack of good men for such specialized work, and ere long there will be an abundance of first class material to choose from. The chief difficulty to-day for the smaller towns, and for the cities that are small in their interpretation of health problems, is to get good all-round men, who can do something in engineering, chemistry, and bacteriology, or at least can grasp the significance of chemical and bacterial analyses; who can distinguish between good and bad plumbing; who can be trusted to choose the materials, apparatus, and methods best suited to disinfect a room or house in which there has been a case of communicable disease, and then carry out the disinfection in a thorough manner; who can inspect dairies, test plumbing, hunt down and suppress the cause of epidemics; who can coax or coerce doctors, nurses, and ministers to obey the laws of their

state and report vital statistics; and who can win instead of repel the confidence and coöperation of all classes of people. Such all-round men are far harder to find than are specialists. When the public realizes their value in reducing sickness and death, and in uplifting the community through higher standards of bodily health, such men will not be lacking. But the public must learn to give adequate compensation to men of this class, and to provide suitable apparatus, books, and assistants.

CHAPTER XXXVII

Day-labor and the Contract System

Although many people favor the construction of sewers, pavements, and the like by labor directly employed by the city, instead of through the medium of a contractor, yet a large percentage of municipal work is still done by contract. Most of the work now done on the day-labor plan is in the nature of extensions or repairs to existing systems, it being quite rare for a municipal undertaking of any magnitude to be carried out from start to finish by day labor. There is, however, a growing tendency for cities themselves to furnish contractors certain materials that need to be of high grade, such as cement, brick, sewer and water pipe. These materials they buy directly from the manufacturers, generally after advertising for bids. This plan has much to commend it, since it removes from the constructing contractor his strongest temptation to cheat or scamp the work.

On certain pieces of difficult work, where the risks are so great that responsible contractors will bid very high, it is undoubtedly better for the city to do the work itself. Then there are occasional

jobs, often comparatively small or inexpensive, where the highest possible grade of work is of far more consequence than the question of cost. As an example, there may be cited a foundation for an immense high-duty pumping engine. The foundation might cost a trifle compared with the pumping engine which is to rest upon it, but imperfect workmanship might wreck the engine. In all such cases, prudence may point to the day-labor plan, but much will depend upon the freedom of the engineer in charge to carry out the work without regard to the political or personal favorites of any other city official. Perhaps a word more should be said about extremely difficult work, or work where the conditions cannot be determined in advance. In all such cases, if the day-labor system is not employed, some plan of payment should be devised that will give the contractor reasonable assurance against loss. Public contracts should never be games of chance, although some risk to both sides is unavoidable.

The chief arguments in favor of the day-labor plan are that the city saves the contractor's profits, a large part of the cost of inspection, and the expense of lawsuits over extras and other disputed points. It is also urged that direct city work is usually superior to contract work; that with the removal of the contractor one chance for the corruption of city officials is removed; and that with each removal of opportunities for deals and steals another incentive for dishonest men to seek office

is taken away. On the other side, it is claimed that the city generally does and often must pay its men more than is paid by contractors; that city employees are not held to their work as closely as the men on contract work, and that there is a more lavish use or waste of materials. Legislation, it should be noted, in some states is tending toward requiring equal wages and hours for workmen under both systems.

Unfortunately there are very few definite figures as to the relative cost of work under the two plans, and practically none as to the subsequent cost for repairs and operation. The meagre figures which have been put forward in favor of either plan are generally useless for scientific comparison, because of the fact that two pieces of work are rarely identical in character or in the weather conditions under which they are executed. Seemingly slight differences in the quality of the material employed, or in the nature of the soil in which trenches, for instance, are being dug, may have a marked effect on the cost of the work. The chances are that municipal work includes no allowance for wear and tear of tools, or engineering and superintendence. It is not uncommon for material belonging to one city department to be appropriated to the use of another without any account of the same being made. These are only a few of the factors that need to be taken into account when considering this question. The author, therefore, makes no pretence of attempting to answer the question

at issue. He would merely sound a note of warning against hasty conclusions on either side, and again call attention to the deplorable lack of proper municipal statistics to help solve this and many other problems.

Among the general sociological problems connected with the question under discussion a few only can be mentioned. When a city does its work directly, instead of by contract, it can oftentimes furnish work or render self-supporting a class of its population that would otherwise require aid from the public funds. If such men could only be paid in accordance with the value of their labor, instead of being placed, as they commonly are, on a par with skilful and able-bodied laborers, the possibility of employing them would be a strong argument in favor of the day-labor plan. But unless great care is exercised, the whole matter of direct employment may result in robbing Peter to pay Paul.

The class of labor employed by large contractors is, in most cases, an objectionable element to bring into the community. This is true, not only because it is drawn from the lowest class of foreigners, but because it is of necessity transient and irresponsible, and adds to the army of "floaters" who are such a menace to good health and good order. Some of the least desirable men employed by contractors remain behind after the work on which they are employed is done, thus adding directly or indirectly to the problems and burdens of the city.

It must be remembered that whatever method is employed, the taxpayers and property owners, and ultimately all wage earners, must foot the bills. Much as there is to be said in favor of an eight-hour day and a "living wage" — two of the points urged by many as among the greatest advantages of direct employment by the city — the man who is trying to pay for his home at lower wages and at longer hours, in some other employment, should not be forgotten. The entire cost of sewerage and paving is often assessed on abutting property, and every man of small means may be vitally affected by the cost. The higher the cost, the more will he oppose the improvement. Generally the work cannot be initiated unless a majority of the property owners favor its introduction. It is, therefore, of great importance to every community, and each home owner and taxpayer within it, that as few mistakes as possible be made in deciding between the day-labor and contract plan of making public improvements.[1]

[1] The leading American writer on the subject discussed in this chapter is Mr. John R. Commons, now of Mt. Vernon, New York. See his articles in *American Federationalist*, January, 1897, to February, 1898; *Yale Review*, February, 1897; *Municipal Affairs*, June, 1900. In general, Mr. Commons is a strong believer in the day-labor, or municipal, as opposed to the contract plan, but in the latest of the articles cited, he reviews the subject in a rather conservative manner, and dwells upon the need of state supervision, particularly in the way of uniform accounting, if the plan in its broader phases is to be successful.

CHAPTER XXXVIII

Municipal Franchises and Contracts

The old-time municipal franchise was usually a most one-sided document, bestowing important and valuable rights and privileges on individuals and corporations, and asking little or nothing in return. Such provisions as were inserted for the protection and benefit of the city and its people were usually so vague and indefinite that the chief gainers thereby were the lawyers who took charge of the suits to settle contentions over the terms of the franchise.

During the last decade municipal officials and taxpayers have been awakening to the fact that reforms in franchise matters are needed. Private companies, too, have begun to see that there is a considerable degree of mutual interest between themselves and the municipalities which they serve and that, even if this was not the case, the strong tide in favor of municipal ownership, now sweeping over the land, renders it necessary for them to change their attitude toward the public or be wiped out of existence.

What, then, are the principles that should govern the framing of franchises in order to meet these

changing conditions, to protect the interests of both the public and the corporations, and to insure the most rapid progress toward ideal relations between these two parties? Assuming at the outset that the franchise will be as clear and definite as legal talent and a mutual understanding of the intended relations between the two parties can make it, its life may be considered. It is generally agreed by all, except those financially interested in franchises, that a life of from twenty to twenty-five years should not be exceeded. Promoters usually make a determined stand for a longer period, urging that so short a term is insufficient for financing the undertaking. With the heavy overcapitalization common to many of these corporations, this claim may be true, but such overcapitalization is contrary to public policy, and is no proper basis for fixing the life of franchises. The financial arrangements of these companies should include a sinking fund, which by the end of the average life of the physical portions of the property would be sufficient to restore all the capital invested. In that case the franchises might terminate at the same time.

Another plan is to grant franchises without limitation, but subject to revocation by the grantor at any time. This, in theory at least, has been the practice in the matter of street railway franchises in Massachusetts. It seems to amount to something very like a perpetual franchise, revocable only for grave cause, since it is doubtful if the

courts would sustain annulment of such a franchise on any other basis, and perhaps more doubtful yet whether the public would tolerate such an interference with a public servant to which it had become accustomed. It must be remembered, however, that the revocation of a franchise rarely, if ever, means cessation of service, and never confiscation of property, so the undertaking would be kept in operation until a reorganization could be effected.

There is a strong demand in some quarters for perpetual franchises under rigid state control as to capitalization, charges to patrons, and character of service rendered. If such control were feasible under present political and corporate conditions, there would be more to be said in its favor, provided it was combined with the right of municipal purchase at any time, without compensation for the value of the franchise.

The great difficulty with the whole franchise question to-day is that too often franchise corporations control the municipality and the state, instead of the reverse. It may be urged that so long as our legislatures are corruptible, deals will be made, regardless of any policy that may be urged. This is only a partial truth. The more corrupt a municipal government is, the nearer may be its impending doom, and when the people are ready to rise in their might and shake off party corruption and corporate abuse, they should not find themselves tied down by unlimited and irrevocable franchises.

However municipal ownership may be regarded, when the right of buying out a franchise at a fair price is reserved to a city or town, it affords the municipality a powerful means of controlling the company, provided the financial condition of the city will permit the purchase. No franchise should be granted without containing this provision in definite terms, supplemented by a clear statement of the manner in which the purchase price is to be determined. The customary plan, that the price shall be determined by arbitration, is, on the whole, the fairest to all concerned. It should be stated in explicit terms whether the price includes the value of the franchise itself or merely the physical plant. If a price for the franchise is included, an explanation as to how this is to be determined should be inserted. This is necessary on account of the variety of methods of estimating the value of franchises — such as capitalizing net earnings at various rates of interest, or placing an arbitrary price on the property as a "going concern." The consensus of opinion among disinterested persons is that when a city virtually gives away a franchise to a company it should regain possession of it without compensation. In other words, a franchise should be leased, never given away or sold.

The purchase clause of a franchise should also specify whether the valuation of the physical plant is to be based on the original cost or the cost of duplication. But the mistake should not be made

of going so far into the details of valuation as to leave the appraisers or arbitrators no discretion, since unforeseen conditions greatly affecting the value of the plant may arise.

Next to the life of the franchise and provisions for purchase by the municipality, comes the question of rates or charges for services rendered. One of three plans, all equally unreasonable, is usually pursued: (1) Nothing at all is said about rates; (2) an inelastic maximum schedule is inserted; (3) it is provided that the rates shall not exceed those in certain other cities. To have the price of monopoly service at the discretion of the monopolist is contrary to reason. To provide that the rates shall not exceed a certain fixed schedule makes no allowance for changed conditions in the future. To base rates on those of other communities is as unscientific in principle as it is impossible in practice, since: (*a*) The rates in the other communities may be changed, owing to changed conditions not common to the city in question; (*b*) the rates in different cities are rarely comparable, being based on different units; and (*c*) even if there were no such difficulties, each company should base its rates on the cost of the service rendered, so as to give a fair return on the capital actually and legitimately invested, including items to cover depreciation and insurance against physical injury to the property. The profit on capital should not be limited to so low a figure as to deprive a company of the incentive to win the in-

creased gains due to good service and economy of operation.

A feature of compensation to franchise companies which is generally ignored or intentionally abused is suitable division of the cost between private consumption and public uses. Sometimes, in the case of lighting or water companies, the streets are lighted or fire protection furnished at almost nominal figures, the private consumer really paying for the public service; or the reverse may be true, private rates being so low that an undue burden has to be placed on the taxpayer. It is far simpler to determine how the cost of lighting shall be distributed between the public and private consumers than to establish a proper basis for the division of the expense of the water service, since in street lighting the city may be regarded as a wholesale consumer of gas or electricity, while the public water service, particularly fire protection, is on a very different footing. This will be more evident when it is remembered that the amount and value of the water supplied are generally insignificant, the real cost of the fire service depending on a large capital account to provide ample quantities of water for a few minutes at more or less infrequent intervals. The pumps, reservoirs, and distributing mains, in fact practically the whole water-works system, are made big enough for these momentary demands and, in the case of pumping systems, fires must be kept banked and men at hand, so extra pumps may be started at the shortest notice.

It is rare indeed for the joint representatives of a city and company to work out carefully the proper distribution of these private and public burdens. Instead, there is a strong tendency for each side, particularly the company, to place the bulk of the burden where it will be borne with the least complaint or resistance. Miscalculations on this one point are responsible for many of the bitter conflicts between officials and private companies over the charges for public service, and also for many of the struggles over private rates.[1]

It will be obvious from the foregoing pages that an adequate control of the rates of franchise companies includes charges for both public and private service. Rates may be under the control of either state or local authorities. They may be subject to readjustment at any time or at stated intervals, or the question may be referred to arbitrators. Where the wisdom of arbitration is conceded, it may be as well, and in some respects it will be much better, to go further and place the control of rates in charge of a capable and honest state commission. Such a commission would naturally have charge of other matters pertaining to the control of franchise companies, such as issuing stocks and bonds and the proposed entrance of a second competing company into the city. No

[1] These statements should not be considered as arguments in favor of municipal ownership, for similar unequal distribution exists under that plan, probably with a more disproportionate burden on the private consumer.

permanent gain, either in the way of lower rates or improved service, is ever secured by a rival franchise company. Consolidation is inevitable, after which the consumer bears the expense of the duplicate works, and the overcapitalization connected with consolidation.

The burning question now left for consideration is, what compensation shall corporations make for franchise privileges? It is a debatable question whether bids for franchises should be on the basis of cash compensation or low price for service, or a combination of the two. Probably the answer should depend on the character of the service and on local conditions. Street railway companies, for instance, should probably pay cash in nearly all cases, because of their great and continuous obstruction of traffic, the added cost of street maintenance caused by their tracks, and because single cash fares are fixed by custom at five cents. There might be reduced rates for tickets in bunches. Cash compensation should rarely, if ever, be a lump sum, since under such a plan one side or the other is almost sure to have unfair treatment. It should be a percentage of gross receipts. No paving, street-cleaning, or snow-removal requirements should be placed on franchise companies in lieu of cash compensation for franchises. The municipality should have a free hand in such work. In addition, the practice confuses the judgment as to the actual compensation given. The sprinkling of that portion of the street occupied by the

street railway companies has more in its favor, since the rush of trolley cars stirs up an intolerable dust, and trolley sprinklers may be operated with ease and cheapness.

The boundary line between municipal franchises and contracts supplementary thereto is not always very distinct, but the same principles prevail to such an extent that what has been said may be applied to both classes. In regard to the length of any contract, whether under a franchise or not, which requires the establishment of a permanent plant, it cannot be too strongly urged that such contracts should be for a sufficient period to enable the contractor to recover the cost of his investment during the term of service without resort to excessive rates. Otherwise he must rely on collusion or bribery for the renewal of the contract.

Considering briefly another class of contracts, those for the construction of public works, for street cleaning, and for miscellaneous city work, the first essential is clear and definite plans and specifications, prepared jointly by an engineer and a lawyer. The contract proper to which the plans and specifications are supplementary, is chiefly a legal document, but in so far as it involves engineering matters it should be revised by an engineer.

All contracts of importance should be advertised fully in one or more technical papers known to circulate widely among contractors, instead of merely placing an advertisement in some local news-

paper. In this way the attention of a large number of reliable contractors will be attracted.

It is a mistake to insist on awarding the contract to the lowest bidder. Even when this requirement is qualified to read "lowest responsible bidder" serious embarrassment and poor work may result. Ignorant or inexperienced men name a figure which will afford no profit and may result in loss; unscrupulous men bid below the cost of good work, relying upon skimping and extras, bribery and fraud, to make up for their low figures. The board which awards contracts should be above suspicion, and should have such a high grade of specialists or advisers that it can be trusted to select a bid above the lowest, or even a relatively high one, if the public interests demand it. Such a policy, however, is fraught with possible dangers. When for any reason such discretion as has been recommended is not vested in the board of awards, it can generally reject all the bids and by alteration of the specifications, or otherwise, and by a readvertisement, avoid the necessity of awarding the contract to a man or at a price that threatens disaster. Of course the usual cash deposits which accompany bids, and also the guarantee bonds for the satisfactory execution of the work, if made high enough in amount and scrutinized carefully as to sureties, will do much to protect the city; but a cancelled contract is a troublesome and expensive matter at best. What a city desires is work accomplished, not the forfeiture of a cash deposit or a bond.

Through failure of the specifications to define clearly the work or conditions, or because contractors are invited to submit their own plans and specifications, it is sometimes puzzling to know who is the lowest bidder. Either procedure is bad enough, but perhaps the latter is the worse, since the bids, instead of being in any true sense competitive, are really so many separate offers to do an essentially different piece of work. Sometimes the results to be achieved can be so clearly and definitely stated, and such guarantees exacted, as to make it perfectly proper to allow contractors to submit and bid on their own plans, but great care must be taken to see that this is the case.

The need of thorough inspection has been mentioned elsewhere. Until the engineers and the inspectors certify that the work is satisfactory in every respect, on no account should final payments be made. Political pressure or personal friendship is so often brought to bear in favor of delinquent contractors as to render a strict adherence to duty here one of the most difficult matters arising in all the ramifications of engineering work.

CHAPTER XXXIX

Municipal Ownership

So much has been written of late on the subject of municipal ownership that one may well hesitate before adding to the discussion.[1] Popular sentiment is largely on the affirmative side, and the feeling is rapidly growing in intensity among the general public. Most municipal officials express themselves strongly in favor of public ownership. It is presumed that many of those who disbelieve in that policy consider it wise, in the present state of public opinion, to keep quiet.

The usual arguments against public ownership of municipal works are that they can be constructed and operated more cheaply and efficiently by a private company; that there is less danger of corruption of city officials; that municipal government is so inefficient that any increase of its powers and duties merely gives added opportunities for the exhibition of incapacity and dishonesty.

Those who favor municipal ownership deny that

[1] See Bemis's (Editor) "Municipal Monopolies" (New York, 1899), to which the present writer contributed the section on waterworks. Also see, as strongly opposed to municipal ownership, Foote's "Public Service Industries" (Chicago, 1899).

private enterprise can construct and operate works more economically. They urge that cities do not have to pay so high a rate on bonds as do private corporations. They contend that the profits derived from these advantages go to benefit the taxpayer, instead of enriching a few capitalists, and that there is at least as great danger of corruption of city officials by companies seeking franchise and other privileges as in the actual operation of similar undertakings.

The author firmly believes that the whole question is one of expediency, rather than of theory. What is needed is not abstract arguments as to whether the construction of gas, electric lighting, street railway, and water-works plants is a proper function of municipal government, but actual facts and figures which shall show under which form of ownership the best service may be secured for the least money. The fact is coming to be realized that the necessary data are not available for answering the crucial question, which form of ownership is most economical and effective? People are also beginning to see that safe conclusions cannot be drawn until both municipal and franchise company accounting is put on a more uniform and scientific basis, and until private accounts are as open to public inspection as are those of municipalities.

Men connected with lighting or street railway companies frequently express themselves in favor of the municipal ownership of water-works. At the same time they oppose that policy for the class

of undertakings with which they are connected. They argue, for instance, that water-works are more fitting subjects for municipal ownership, because they are so much simpler in construction and operation. As a matter of fact, the building of a water-works plant requires as high a grade and a greater diversity of engineering skill than any other public work. Its operation is quite as difficult and the sale of water, except where a universal meter system has been adopted, is much more complex.

So far as engineering has to do with municipal ownership, the questions involved are simple. There are plenty of good engineers ready to design, execute, and if need be operate, any of the undertakings included in this discussion. Most of our best hydraulic engineers have been connected with municipally owned water-works, largely because nearly all our great cities and over half of our municipalities own their water supplies. On the other hand, the majority of the great electrical engineers are connected with private lighting or street railway companies, because such enterprises are chiefly under private ownership. Competent engineers can build works as cheaply under one as the other form of ownership, provided the politicians do not interfere under municipal ownership, and that there are no inside construction companies or favored stockholders or officials who must have a profit from the contracts in the event of private ownership.

Municipalities can generally raise money at lower rates of interest than private companies, but the former are pretty sure to pay higher wages, hour for hour. The difference in wages, however, may possibly be eliminated in the future by legislation requiring the same rates for all men on municipal or franchise work.

Private companies are by no means free from the dictation of political bosses in the selection of employees. Neither are they free from levies for campaign expenses, nor from other demands on their treasuries that could not be specifically charged on their books if the latter were open to public inspection.

It is generally supposed that private companies retain their men longer than do municipalities. The only attempt to compile definite figures of wide range bearing upon this subject, so far as the author is aware, was made by him a few years ago and published as an editorial note in the *Engineering News* for November 4, 1897. The studies were based upon returns of the names of water-works superintendents at various intervals, for "The Manual of American Water-works" for 1897 and 1890–91, of which the author was editor, and for "The Statistical Tables of American Water-works" for 1887 and 1883, which book was the predecessor of the "Manual." The periods covered were approximately five, ten, and fifteen years, respectively. In the original the compilation is given by groups of states for each period,

but it will be sufficient here to give the results for the whole country. For this purpose the note in question may be quoted in part, as follows: —

The total number of names of water-works superintendents of both classes were 909 for the five, 399 for the ten, and 269 for the fifteen year period, fair numbers, certainly, both in themselves and in proportion to the number of works in existence in the United States at the beginning of each period, there being described in the 1890–91 issue 2037 water-works in the United States against 1328 in the 1887, and 750 in the 1883 issue.

For the whole country and for nearly all of the groups each of the three periods shows a greater permanency of office among the private than among the public works, but the difference is not so great as might have been expected, especially in the last two periods. For the first period 62 per cent of the private and 46 per cent of the public works made no change in their superintendents. For the second period, of about ten years, no changes occurred in 39 per cent of the private and 31 per cent of the public works, while in the last, or fifteen year period, the relative percentages were 34 and 23. The differences in these percentages of permanency for the successive periods were only 16, 8, and 11, respectively, in favor of the private companies. In general the Eastern and Southern groups of states make a better showing than the balance of the country for both classes of works, the men themselves, perhaps, having less tendency to change occupation or residence than in the West. In the New England states the public and private works make practically the same showing, and that a high one, for each of the three periods, while in the Middle group the private are far ahead of the public throughout.

Disregarding ownership, the percentages of works which retained the same superintendent are 55 for the first, 35 for the second, and 27 for the third period. Many of the changes on each side have been caused by death, a factor that could not be fully ascertained and so has been ignored. In many other cases of change of superintendent some other official

has retained a responsible position throughout the period. Altogether, then, our American cities are to be congratulated on the permanency of the management of their water-works; and the difference between private and public ownership in this respect is not so marked as opponents of public ownership, and municipal reformers, also, have urged, although there is plenty of chance for improvement in each respect. It is equally to be desired that good business management and permanency of office prevail under each plan. Unfortunately there are many conspicuous lapses in both cases.

There remains for consideration the relation of municipal ownership to the health of the community. The water supply is the chief concern here, since it is practically the only sanitary service that is intrusted to franchise companies. There are, however, a few sewerage systems in the United States, owned and operated by private companies. The garbage collection and disposal service is more frequently left to private enterprise, but is rarely made the subject of a franchise. As a rule it may be said that such exclusively sanitary services as sewage and garbage should be under municipal ownership. The exceptions will be an occasional community where, through legal or financial complications, municipal ownership is temporarily impracticable. Under such conditions the franchises should provide for ultimate assumption by the city or for full control by it from the start. The character of the service and the charges to patrons should be regulated in the interests of good sanitation and the widest possible patronage by all classes.

A pure water supply is of far more importance to a city than either sanitary sewage or garbage disposal, but water is furnished for many purposes not affected by purity, and the people are more ready to pay for having clean water brought to them than for having it removed after it has been fouled. With efficient state and local boards of health a pure water supply can be secured under private ownership, but nevertheless sanitary considerations favor municipal ownership of waterworks. It is often true that a city is in better condition to conserve the purity of the supply than is a company, besides being more willing to spend money for the purpose. If it is desirable to furnish water at less than cost, either to small consumers as a sanitary measure, or to large ones to attract manufacturers, it will be possible only under municipal ownership.

CHAPTER XL

Municipal Expansion by Annexation and Consolidation [1]

In the commercial rivalry between modern cities, the desire to excel in size plays a most important part. The prefix Greater, originally applied to London to distinguish the metropolis from the old walled city, is coming into common use to describe cities enlarged by the wholesale annexation of outlying districts. Chicago increased its area fourfold some ten years ago and omitted to use the word, perhaps because nothing short of the superlative degree will suffice in that breezy city. It remained for the consolidation of New York and Brooklyn and all their outlying suburbs to give wide currency to the term greater to record municipal consolidation on a large scale.

The enlargement of municipal boundaries is confined to neither this decade nor country, although in the past ten or fifteen years it has been carried to a far greater extent and conducted in a

[1] This and the succeeding chapter have been rearranged and partly rewritten from an editorial by the author in *Engineering News* for February 16, 1899, and from an article in *Municipal Affairs* for March, 1899.

less reasonable manner here than abroad. Much of this municipal expansion has been a necessary accompaniment of the magical growth of cities. Overflowing populations in the suburbs have been absorbed by the mother city by the force of common interests and real political unity. The extension of city limits in this fashion is in no manner to be deprecated.

On the other hand, the extension of the limits of many cities, especially in the West, has been made in advance of the growth of population, for the benefit of real estate speculations in tracts outside of the city limits. The extensions of streets, sidewalks, and water mains, which have frequently accompanied such ill-advised expansion, have saddled the taxpayers of many cities with a load of debt for which they are receiving no corresponding return. Enlarging the limits of a city by the annexation of outlying rural districts naturally increases the urban area much more than its population. There is, however, another form of municipal expansion which affects much more vitally the population included. This is effected by the consolidation under one charter of neighboring cities and towns, previously existing under distinct local governments. Of this form of municipal expansion, New York is the most notable example.

What are the advantages in joining under one municipal government the chief city at a centre of population and the outlying independent munici-

palities which have grown up around it and have developed a distinct character and population?

There are three considerations which are likely to induce neighboring municipalities to consolidate: (1) The desire for mere bigness of area and population; (2) the wish to include under one government the business and residential sections of a community; (3) the necessity for neighboring cities to combine for certain functions, as a water-supply or sewerage system. These considerations will be briefly considered in the order named:—

(1) It is claimed that a city derives a direct material gain from the fact that it has more inhabitants than its competitors. Large centres do certainly attract investors and residents; but is it not the case that it is the population in a given district and not the number under one municipal government that constitutes the attractive feature? Again, has not the advantage of mere figures been overestimated in the popular mind? The fact that census figures show a certain growth may influence speculative purchases of real estate; but are these weighed by the manufacturer looking for a site for his works or by the home-seeker looking for an attractive residence? Many a manufacturer, within the past decade, has abandoned a site in a large city and has moved to some place in the country where land is cheap, where works can be planned with abundance of room, where workmen can live comfortably at a small part of the cost of life in a city tenement-house, and where, in consequence,

a better class of workmen can be secured. From this point of view, it can be readily seen how idle is the hope that manufacturing industries will be attracted to a great city merely because of its absorption of the cities lying adjacent to it.

(2) One of the most common motives for the enlargement of municipal boundaries is the wish to unite wealthy residential suburbs with the main city. Often these suburbs would not exist were it not for the larger city, and there is some show of reason for bringing them into the city limits and making them contribute to the support of the city where most of the residents carry on their business. But equity will seldom demand annexation on this score. If the suburbs share in the public service of the city, through coöperation or otherwise, they bear their part of the expense. The business investments of such suburban residents are in the cities and are taxed there.

(3) There is another reason for consolidation of adjacent cities, which deserves much greater consideration than the argument for mere swelling of the figures for population and area. There are certain municipal functions in which adjacent cities cannot well act in entire independence of each other. Such are the provisions for public water supply, drainage, and sewerage, and transportation facilities, including in the latter not only street railways, but general street and boulevard plans, and in some special cases the provision of important bridges. Another class of municipal

functions can be carried on more advantageously when the control of the entire centre of population is under a single head. Such are the provisions of police and fire protection; the design, construction, and maintenance of a comprehensive park system, and the supervision and control of private corporations furnishing gas or electric light supplies.

If there were no other way of securing common action and control of these matters, the fact would be of sufficient importance to outweigh all other considerations and cause adjoining municipalities to unite under one government. In the following chapter a description is given of the method adopted by a few cities to enable them to maintain a common administration of their joint needs without sacrificing their individual existence.

But what, it may be asked, are the objections to consolidation? Why are the smaller neighboring cities often unwilling to take the name and share in the government of a larger city?

The two most obvious objections to consolidation are (1) the sacrifice of local interests, traditions, and personality, which small communities must make when they become absorbed in a large one; (2) the heterogeneous and mutually indifferent character of a population that is formed by combining different local governments, and the resulting apathy concerning public affairs.

As New York is the most recent and notable example of consolidation on a large scale, a brief study of her experience will be instructive.

When the agitation for creating Greater New York was begun, about 1890, there were in the area in question three cities and sixteen townships, the latter including twenty-six villages of an average population of about 2700. The total population of the district was then about 2,500,000, of which some 2,385,000 were in the three cities. The population of Greater New York, by the census of 1900, was 3,437,000 and its area 306 square miles. The framers of the original charter recognized, to some extent, the vastness of the area and population they were bringing together under one municipal government, and the inchoate condition that would result unless local divisions and powers were retained. They therefore divided the city into five boroughs, and still further into twenty-two so-called improvement districts. For the most part, these districts proved mere areas. No vestige of local self-government remains to the original municipal areas, nor has any been conferred on the boroughs or improvement districts. It is difficult, if not impracticable, for the people of the original forty-five communities to make their wants known, much less appreciated, by the central authorities. Such purely local questions as the opening and improvement of streets, the control of schools and libraries, cannot be settled by the will of the locality, because the majority of the members making the decisions are elected from other sections or appointed by the mayor. As a result, interest in city government is bound

to languish as time goes on and the people realize their helplessness. Past traditions, local autonomy, and local pride have all been surrendered. Thus far the most notable results perceptible are the satisfaction of the longing for bigness in area, population, and wealth, and a rather full and seething measure of sectional strife in the municipal assemblies and some of the other central bodies.[1]

What the smaller places will ultimately gain by sinking all individuality and self-government in Greater New York will not be predicted. Some of them may have lower taxes, but for how long? And if so, was it for the interest of the larger cities to take them in? As an offset to all possible advantages we see an immense population, with a great variety of local traditions, interests, and conditions, struggling under one city charter. The 3,500,000 people now living in Greater New York are exceded in number by the population of few states in the Union, and will soon equal the population of the whole United States in 1790. To govern such an aggregation of people under a municipal charter is something never before attempted in a republic. Greater London has more people, but it is composed of separate local governments, having charge of purely local affairs, with the County Council in charge of certain interests

[1] The new charter, enacted in 1901, to go into effect on January 1, 1902, gives the boroughs more local self-government than they possessed under the original charter.

common to the metropolis, such as the main sewerage system.

It is scarcely known that while the agitation for Greater New York was in progress, metropolitan investigation commissions were at work in both London and Boston, and that each recommended a county form of government with the largest possible local autonomy, instead of any great scheme of consolidation. The possibilities of the county form of government and of other forms of coöperation as a substitute for consolidation will be considered in the following chapter.

CHAPTER XLI

Municipal Coöperation a Substitute for Consolidation

Municipal coöperation is a form of government under which two or more municipalities, otherwise distinct, unite for the performance of some function, such as the provision of a public water-supply or park system. The problem which it aims to solve is that of unifying metropolitan areas without sacrificing local self-government in the several units. This has been done in two ways: (1) By establishing an enlarged county government over the area involved, and (2) by the appointment of special boards of commissioners, each of which shall have charge of one department of coöperative work. The county government of Greater London is a typical example of the first plan, and the metropolitan boards which serve Boston and her neighbors, of the other.

In 1855 a Metropolitan Board of Works was formed in London for the construction of a main sewerage and drainage system and other important public works. The jurisdiction of the board extended over 101 parishes, but to simplify matters 78 of the smaller areas were formed into 15 districts. The parishes were governed by vestries and the districts by boards. The Metropoli-

tan Board of Works was composed of members chosen by the several vestries and boards. In 1899 the board was succeeded by the London County Council, to which greatly increased powers were granted. In 1900 many of the smaller parishes were abolished and a number of boroughs created. The whole tendency in London seems to be toward a most extensive use of coöperation, combined with the broadest possible measure of local self-government.

To the superficial observer, the twenty-eight or thirty towns and cities within a radius of some ten miles from the State House in Boston offer the most promising field in this country for municipal consolidation on a grand scale. It seems inexplicable to some that these municipalities have not merged their identity in a Greater Boston, and inevitable that they must do so very soon. But, as a matter of fact, it is doubtful whether such a consolidation will take place for years to come, if ever. One of the great reasons for this doubt is the fact that in the past few years three great schemes of municipal coöperation have been undertaken with results which the residents of the several cities and towns refer to with great pride and satisfaction. These, in the order of their inception, are: The Metropolitan Sewerage, Park, and Water Systems.[1]

[1] The Massachusetts legislature of 1901 passed an act which created a Metropolitan Sewerage and Water Board in place of the original sewerage and water boards.

Independent districts, largely but not wholly the same in area, each with separate commissions in charge, were created by the legislature to provide general sewerage, park, and water systems for Boston and the surrounding towns. Both natural and economic considerations have made advantageous if not imperative some joint action for supplying these common needs. Communities with less popular intelligence and more reason for distrusting their public officials might have found it difficult to agree on such schemes without actual consolidation and unity of government.

In the case of the cities about Boston, however, public sentiment was in most cases strongly opposed to consolidation. The local town and city organizations dated back scores and in some instances hundreds of years. The people were proud of their respective cities and loath to merge their identity and lose their control of their own local affairs. On the other hand, the need of comprehensive provision for the whole metropolitan district was recognized in the case of the sewage disposal, the water supply, and the park system alike. As a result the plan of municipal coöperation already outlined was adopted. The manner in which it has been and is being carried out warrants the statement that nowhere in the country are there public works more excellent in design and execution or better suited to the wants of the communities they serve. All this has been done without sacrifice of local autonomy, with less

delay, and with no more expense than would have resulted if a Greater Boston had done the work.

These metropolitan commissioners are appointed by the governor. The funds necessary to carry out the work are raised by state bonds. Each of the communities served contributes an apportioned yearly amount for interest, sinking fund, operation, and maintenance. Each city manages its local water and sewerage system, the supply, in the one case, and the common outlet sewer, in the other, being controlled by the commission. In the same way each city maintains its own parks, the park commission controlling only the large parks and parkways which are the common property of the district.

In 1896 the Metropolitan District Commission, created in accordance with an act of the Massachusetts legislature, reported in favor of a county government for Boston and its suburbs similar to the London County Council. The duties of the park, water, and sewerage commissions were to be vested in a body of men directly responsible to the people, instead of to the governor. This proposal has much to recommend it, the county being an old and familiar institution. There are also many objections. The joint works generally needed are difficult of execution and need the oversight of men specially trained for the work. Such men are more likely to be secured by appointment than by election. Unquestionably the best managed municipal works in this country are controlled

by special boards, rather than by city councils. For the same reason it is probable that coöperative enterprises will be better carried out by specially appointed commissions than by an elective county government. It is still possible and, for legal and financial reasons wise, to make the coöperative districts coincide with county boundaries.

If it be urged that Massachusetts is an exceptionally progressive state, and its action in public matters is in advance of what can be secured elsewhere, it may be answered that, so far as municipal coöperation is concerned, there are some notable instances of it in New Jersey, which is conservative in many lines of state policy. In Essex County, New Jersey, Orange, Montclair, and Bloomfield constructed and operate an outlet sewer for the joint use of the three municipalities; East Orange and Newark have still another; and plans have been made for a third, to serve a part of Newark, Irvington, Clinton, Vailsburg, and South and West Orange. This county has long been noted for its excellent system of macadam roads, some of which have been provided by the county government. A large part of the county has a common source of water supply, served through independent local distributing systems, and the same is true of public lighting. Its street railways, also, are included in a single great system and in the control of a single corporation. The water supply (outside of the distribution), lighting, and street railways are provided by private corporations, but they are

none the less common to a number of towns in the county.

Of more significance still is the Essex County Park System, for which $4,000,000 have been voted and some $3,000,000 already expended, in order to provide a comprehensive system of parks and parkways for the whole county.[1]

In conclusion, the problem of securing honest and efficient city government is already so vast and perplexing, and one which so deeply concerns the well-being of all city residents, that further increases in the size of cities, except those due to natural growth, should only be made after most careful consideration. If municipal coöperation can be as successful elsewhere as in Boston, Brookline, Cambridge, and the adjoining cities and towns, and as has been the case in Essex County, New Jersey, the idea may well be extended, both for its direct worth and as a safeguard against the craze for immense cities, which promise to be big, rather than truly great. It is true that the present is an era of trusts and combinations in the commercial world, and it may be urged that city consolidation is but a move in the same direction. Under present political conditions, however, and while civic duties rest so lightly on the shoulders of most urban voters, we may well say, beware of huge municipal trusts!

[1] See the chapter on parks for more information relating to both this and the Boston Metropolitan Park System.

CHAPTER XLII

Uniform Accounting and National Municipal Statistics [1]

One of the greatest drawbacks to municipal progress is the lack of correlation and coöperation between the different departments composing city governments, and the still greater lack of coöperation between cities as a class. Our cities do not act as units, but as aggregates of units, each of the many branches or bureaus struggling, as indeed it must under the circumstances, to get its share of the appropriations. Although this is true to a large extent the world over, it is more strikingly so in America than in other countries, owing largely to our lack of central administrative control, both in city and state. In England, which in many respects is less highly centralized than other European countries, we find nearly all municipal functions in the hands of councils, while the actions of those bodies are controlled to a marked degree by the Local Government Board. In the United States the control

[1] The first pages of this chapter have been taken, with slight alterations, from an editorial by the author in the *Engineering News* for June 14, 1900.

of public works by city councils has been in inverse proportion to the number and magnitude of the works in hand; that is, one branch after another of municipal service has been cut off from the council, and intrusted to separate commissions, until it is not unusual to find a single city with water, sewer, street, fire, health, and lighting departments, entirely separate and independent of each other and of the city council, except that some, but by no means all, of these departments may be compelled to look to the council for appropriations.

Between the several municipalities of a single state there is often scarcely a common tie, save that each and all are under the same constitution and the control of the same legislature. Most of the constitutions, however, were drawn before our cities attained to anything like their present rank; and the cities and towns are operating, in so many instances, under special charters and acts that a common legislative control means comparatively little in common after all. Cities in different states of the Union have absolutely nothing in common, of necessity, except a few rights to individuals guaranteed by the Federal constitution.

When our cities were small, all these dissimilarities were of little moment; in fact, many of them did not come into existence until brought out by the enormous municipal development of the last few decades. But with the growth of municipal functions, correlation and coöperation are becom-

ing of the greatest importance; otherwise progress is retarded by useless and easily avoidable friction between departments of the same city and between rival cities and towns, and both municipal departments and different municipalities will fail to profit by the experience of predecessors in the same or similar paths.

One of the greatest opportunities for advance is a thorough-going reform in municipal accounting, notably in the direction of uniformity. The need for uniform municipal accounting is becoming more and more evident. It is forced home upon every committee and official appointed to learn how other cities and towns are solving a given problem, upon every convention of municipal officers, and upon such governmental departments of the state or nation as undertake the collection of information relating to cities. The deplorable lack of uniformity found by all investigators is not confined to differences between states nor cities, but extends to the various departments of almost every city and village in the land; nor does it stop here, for it is a common thing to find a single department changing the plan or scope of its bookkeeping year after year.

The vast majority of municipal departments have wofully deficient systems of bookkeeping at the outset, and annul a large part of the value of those by frequent changes and omissions of details, and even suspensions of accounts. In thousands of cases departments of more or less

importance really keep little or no more than a cash account, subdivided, perhaps, to correspond roughly with the various branches of the department, but with entries most unsystematically distributed to the branch accounts whenever the slightest complexity arises. Charges against or in favor of another department are comparatively rare; or if made, are mere debit or credit items in a general cash account. If a water department supplies cast-iron pipe from its stock to the sewer department, no entries may be made on the books of either department; while if cash is paid for the pipe, it is likely to be entered with the ordinary receipts (revenue from water consumers) of the water department, and stands only a fair chance of being properly accounted for in the sewer department. But if, instead of pipe, the water department supplies water to the public schools, sewer, fire, and street departments, probably in nine cases out of ten the water department gets no credit whatever for the services rendered. This is a serious matter, particularly in the case of the fire department, since a large part of the original cost of a water-works system, and hence of its capital charges, is due to making the works ample for fire protection, and therefore should fall upon the property benefited rather than the water consumer. If the burden were properly distributed, it would be easier to raise funds to improve the character of the water supply, and also to reduce water rates, so the blessings of pure water

would be extended, and the health of the community greatly increased.

An essential but frequently neglected point in municipal bookkeeping is the distribution of expenses for public works between construction and operation, or between capital account and current expenses. The importance of this cannot be emphasized too strongly. The whole question of the comparative merits of municipal and private ownership of public works, from the financial side, must be settled by a study of the relative cost of constructing and operating such works. It is necessary that the figures be accurate and properly classified.

The need of reform in municipal bookkeeping is threefold in its scope: (1) Each department should establish a satisfactory system of accounting, and then maintain it year after year; (2) the different departments of a city should coöperate in determining the method of compiling their records and keeping their books, so that the work of the different departments of a single city may be easily comparable; (3) common schedules for corresponding departments in different cities should be adopted. If the last should be done, the first two reforms would follow naturally, but until then each city must wrestle independently with its problem of improving its bookkeeping.

The work thus far accomplished in the United States in the way of uniform municipal accounts and reports has proceeded along three main lines: (1) State supervision of accounts, sometimes involv-

ing state audit, and, in one or two instances at least, including annual reports to a state officer on forms prescribed by him. (2) State administrative control of certain local interests or industries, such as street railways, lighting plants, sewerage systems, water-works, vital statistics, assessment and taxation, and public schools. (3) Voluntary action by organizations devoted to some branch of municipal activity, such as water and lighting plants, pavements and sewers, street railways and municipal laboratories.[1]

Just how municipal statistics can be secured for the whole country most advantageously is a question that must have serious consideration in the future. The results attained by the tenth and eleventh censuses were far from satisfactory. The bulletins on the subject issued by the United States Department of Labor in 1899, 1900, and 1901 (September numbers), while in some respects in advance of any previous work of the sort, con-

[1] Progress in these lines of work was reviewed in detail by the author in the *Engineering News* for July 5, 1900. The review was brought down to the close of that year, and reprinted as an appendix to the report (December 29, 1900) of the committee on Uniform Municipal Accounts and Statistics of the American Economic Association, of which committee the author is chairman. The review included quite an extensive bibliography of the subject of uniform municipal accounting and central administrative control, and was supplemented by a list of members of committees on uniform accounting recently appointed by ten national and one state association interested in municipal affairs. The committee of the National Municipal League is attempting to formulate summary schedules for municipal receipts and expenditures.

tained many defects, besides being confined to cities of thirty thousand and upwards. The defects are freely admitted by the Department and are attributed largely to this very lack of proper and uniform accounting, already discussed. With these defects removed or materially reduced, either the department in question or the census office could and doubtless would do much better work. It is questionable, however, whether any census office, short of a permanent one, can fill the need. To be of much service, municipal statistics must be gathered oftener than once in ten years and must be made available much more speedily than is customary with census publications. If a Department of Commerce and Industry, as was contemplated in a bill introduced in Congress in 1900, were established, and most or all the statistical work at Washington placed in its charge, a municipal department might be one of its most prominent and valuable features.

Much might be achieved by the creation of State Boards or Examiners of Municipal Accounts. With such central bodies in existence, vested with power to require uniform accounts, to audit the same, and to require yearly statistical reports from every municipality, national municipal statistics, though still very convenient and highly desirable, would be less important.[1]

[1] Wyoming has a State Examiner of Accounts, whose work thus far has been limited chiefly to state and county departments. State control over city or township accounts also exists, to some extent, in Virginia and Indiana.

CHAPTER XLIII

Taxation, Assessments for Benefits, and Bonded Indebtedness

Though the engineer has little control of questions of taxation and bonded indebtedness, they naturally affect the character and extent of the work under his direction, since they limit the amounts available for public improvements. For this reason there is a close relation between sanitation on the one hand, and taxation and bonded indebtedness on the other. Since the period for which bonds for different classes of public works should run is partly dependent upon the life of such works, the engineer may be consulted in this particular. He may be called in likewise to aid in assessing certain forms of property for purposes of taxation, particularly works designed and erected by engineers.

Inasmuch as the proper development of public works depends so largely upon the sums that may be raised by taxation and bond issues, a few words on these subjects may properly come within the scope of this book. It is to be noted, first, that the raising of money by state and by local taxation should be separated as completely as possible.

This seems to be the only way to lessen the prevalent inconsistencies in percentages of assessed to total valuations. Much the same thing is true of county and municipal taxes, but in this case it is not so easy to keep the respective objects of taxation separate as with state and local taxes. There is a growing tendency, it may be added, to raise money for state expenses by taxing corporations, like railway and express companies, whose business extends throughout the state. It is a well-known fact that a large percentage of personal property escapes direct taxation, although in theory all property is supposed to be taxed at its full valuation. The problem of the future is how to equalize the burden of taxation, both as between different communities in a state and between individuals. The question is too large and complex for discussion here, even if it related more closely to the subject of this book. The most that can be done is to urge upon municipal officials the necessity of reform in taxation, so that money for sanitary and other public works may be raised more easily, and at the same time the burden of taxation be kept down to such an extent that it will be less difficult for the poorer classes of the population to join fully and heartily in all wise efforts for their sanitary benefit.

The engineer and the student of municipal affairs may well join in attempting to show more clearly than has yet been done what the taxpayer really gets in return for his contributions.

A low tax rate does not always mean a wise or economical management of public revenues. For instance, in some communities with low taxes public improvements are at a low ebb, or all possible services are rendered by private agencies, or the cost of nearly all public improvements is met by assessments for benefits. Rarely, if ever, has an attempt been made to show what all the services supplied or controlled in greater or less measure by the municipality really cost the citizen, and to compare this total cost with the total services rendered.

As to bonded indebtedness, it is neither good finance nor good engineering to issue bonds for anything but permanent improvements. At the other extreme, municipal improvements may be greatly hampered by placing the sole or chief reliance for permanent works on the proceeds of taxation. Such a policy must of necessity result in the tardy satisfaction of a city's needs.

There is a strong movement in some communities to exempt from the bonded indebtedness limit all issues of securities based on revenue-producing works. This principle has been observed in the legislation of certain states, apparently without harmful results, in the case of water-works bonds. Whether it would work as well for lighting, transportation, and municipal docks and ferries is an open question. There is also a counter proposition, not yet put in practice, to limit the security of bonds for such municipal undertakings to the

plants alone, instead of placing it on the whole body of municipal credit, as is now the practice. How capital seeking investment in municipal bonds would view this plan remains to be seen.

Two closely connected matters relating to bonded indebtedness are the period for which bonds should run, already mentioned, and the provision for redeeming the bonds when due, instead of reissuing them. One of the strongest arguments for meeting the cost of public works by bond issues instead of by taxation, is that such a plan distributes the burden over a longer period of years, so those who benefit by it will contribute toward the cost throughout the period of usefulness. If this is correct in principle, then street paving bonds, for instance, ought to be coterminous with the life of the pavements, in order that when the latter are worn out there will not be the double burden of the old paving bonds and a new issue for renewing the pavements. It is for the engineer to say, as best he can with present data, what is the life of different classes of public works.

In some of our states, particularly in the South, public improvements are nearly at a standstill, owing to constitutional restrictions as to bonded indebtedness and taxation, and, in some cases, to the absolute prohibition of assessments for benefits. It is very questionable whether, if public policy demands state regulation on any or all of these points, it might not far better be intrusted to central boards of municipal control.

More perplexing and troublesome than the question of bonded indebtedness or general tax levy is that of assessments for benefits; for in the former, that indefinite and intangible unit, the general public, is to be dealt with, while in the latter, the direct, personal element of individual property owners has to be encountered. It is evident that most public improvements, as pavements, waterworks, and sewers, confer a benefit upon both the general public and the abutting property owner. The cost of such improvement should therefore be divided, in accordance with some carefully formulated rule, between the general tax levy and the assessment on the particular property benefited. In the general tax levy the payment usually comes in the form of interest on bonds and a sinking fund to redeem them, although a portion of the cost of construction may be met by direct taxation.

If the whole cost is met by a general tax levy, it will be difficult to secure money for extensions. Particular opposition is encountered from those people who are on the streets where the improvements have already been made. If the whole cost is met by individual assessments, property owners will try to prevent the improvement of their particular street, to the detriment of the general public. The problem, then, is, How shall the cost be divided? A valuable addition to the theory and practice of this subject has been made by Mr. F. Herbert Snow, formerly city engineer of Brockton, Massachusetts, in the form of a report on the

best method of raising the money to meet the cost of building and operating a sewerage system for that city.[1] The principle of Mr. Snow's plan, applied to all classes of municipal improvements instead of being limited to sewers, are these: He divides assessments for benefits into (1) those which correspond to an increase in the value of property caused by the introduction of the improvement, whether or not the owner avails himself of the use of the improvement. This would apply to idle and unimproved property, and also to residences, in case of water mains or sewers put through the streets, but with no connections made with them by the residents. (2) Those in which the benefit to property owners comes through actual use of the service introduced. The whole cost of construction, Mr. Snow concludes in the case of the Brockton sewers, should be paid one-fourth by assessment of all property abutting on the sewers, whether connected or not, one-fourth by users, and one-half by the general public. This plan is particularly adapted to sewers, and requires modification when applied to a revenue-producing improvement like water; in fact, Mr. Snow terms the second apportionment a rental, and bases it on the amount of use as indicated by the water consumption of the user. Mr. Snow shows that the area or frontage plan, alone, of determining assessment is inequitable, and suggests a combination of

[1] This report was outlined and discussed in *Engineering News*, July 19, 1894.

the two, 60 per cent on the area within 125 feet of the street line, and 40 per cent on the frontage.

In the brief space allotted to this closing chapter, the author has attempted to lay down certain general principles, but the peculiar conditions surrounding each individual case will make their application difficult and susceptible to endless modification. It is a strange but common defect in the moral nature of the average citizen that though honest and upright in his ordinary business transactions and relations, he will stoop to evasion and concealment when his creditor is the general public. With a higher standard of civic virtue, obtained by a vigorous campaign of education, many of the problems connected with taxation will disappear.

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